The Chemical Age

A Weekly Journal Devoted to Industrial and Engineering Chemistry

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NOTICES :—All communications relating to editorial matter should be addressed to the Editor, who will be pleased to consider articles or contributions dealing with modern chemical developments or suggestions bearing upon the advancement of the chemical industry in this country. Communications relating to advertisements or general matters should be addressed to the Manager.

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1928-29

IN our general summary of the events that have happened in British chemical industry, the year that is just closing is described as one of consolidation and expansion. This estimate is at once confirmed by Sir William Alexander, M.P., in the first of a series of individual reviews published in this issue, when he speaks of 1928 as a year of accomplished recovery and accelerated progress, and predicts that 1929 will be distinguished for the application of science to industry on a greatly enlarged scale. The conclusions of the group of eminent writers who from different angles discuss the branches of chemical science or industry with which they are associated are in general agreement with this view. The position in nearly every case is better at the end of the year than it was at the beginning; the coming year is looked forward to with general confidence and with an expectation of definite progress on the scientific side, which means in the end the improvement and development of all the industries dependent on science.

No one can study the carefully prepared contributions of these writers without realising the enormous part that chemical science and industry play in the industries of the country. Not only is the chemical industry a unit of great importance in itself; it is even greater as the source from which most of the other industries obtain their essential supplies. The desire often expressed in recent years for a fuller public understanding of chemistry's service to the nation is being realised, not because distinguished writers have been good enough to tell the people what is being done for them, but because the people themselves see the new products that chemistry is constantly producing for their service. They see new and inexpensive clothing, delightful in design and colouring, brought within the range of very limited means; working women and girls dressed immensely better and more attractively than were the county ladies of a generation ago. They see diseases that were formerly held to be incurable alleviated if not remedied by the medicinal products of laboratory research. They see nature, as in the case of synthetic nitrogen, compelled to make new contributions to the needs of the world, and raw materials like timber turned to uses that a generation ago would have seemed magical. They see our basic product coal put into the chemical hat and transformed into a bewildering variety of things for use in works, in the home, in agriculture, and in numberless other relations. They see new and flourishing industries growing up as the result of something done by mysterious beings at work in laboratories. Slowly a public consciousness is being awakened to the endless practical services that chemistry renders to society, coupled with a growing belief that should our national raw supplies run out in any direction the chemist will forthwith produce something as good or possibly better to take their place and supply our wants.

While the public are thus beginning to realise the practical fruits of chemistry and the importance to the nation of a vigorous chemical industry, the industrialist whose business it is to convert laboratory achievements into commercial production is also coming to realise that research is the life-blood of industry. It is no longer a luxury, except in a few instances where its essential nature is not understood; it has become as much an essential to progressive industry as food is to the body. Where the great progressive and prosperous concerns lead the way, the lesser ones must inevitably follow. The habit of reminding ourselves of the example of Germany is properly falling out of fashion, yet no one can study the figures given by our competent Patents Correspondent on the chemical inventions of the year without being impressed with the preponderance of chemical patents taken out in this country and owned by continental, more especially German, interests.

These facts are drawn attention to not as a dis-

paragement of British enterprise, nor as illustrating the past lack of it, but to show, now we are awake to the situation, how much lost ground has to be made up. That it will be made up in time there is no reason to doubt. Substantial progress has been made in recent years, not only by private enterprise, but under the wise and vigorous direction of the Department of Scientific and Industrial Research. It seems only yesterday since the announcement was made of a new chemical research laboratory at Teddington under the direction of Professor Morgan, who started with nothing and had to create an entirely new organisation. Some doubts were expressed at the time as to whether any form of real research could flourish under State control. The convincing answer to such doubts is found in the record we publish this week of the researches started and the results already achieved in such fields as low temperature tars, chemotherapy, metallurgical and especially corrosion problems, high pressure gas reactions, and synthetic solvents and resins. There is, again, a great group of industrial research associations, in which public and private co-operation is happily united, for the study of the problems of particular industries. In short, chemical research is at last beginning to march, to the present benefit of British industry and to its safeguarding and expansion for the future.

This week we publish a larger number of articles than we have ever before included in a single issue reviewing the year's progress in many branches of chemical industry. To discuss them all here would be impossible; all one can do is to indicate a few of the many points of interest that emerge. In the comprehensive review of the work of Imperial Chemical Industries, for example, mention is made of several new activities—the construction at Billingham of a new 165 tons-a-day ammonia unit and progress with further extensions; the manufacture of glycol, a substitute for or at least a competitor with glycerine; a new ammonium type of low-freezing gelatinous explosive, about to be put on the market; and several colonial developments, including plans for the production of synthetic oil and motor spirit in Australia. Mr. Davidson Pratt's general survey of chemical industry indicates the sustained activity of the Association of British Chemical Manufacturers, and contains some striking facts relating especially to progress in fine chemical production. It is interesting to note that although synthetic Vitamin D was first produced here, its use in Germany greatly exceeds its use in this country. The dyestuffs field is covered from the users' point of view by Mr. Sutcliffe Smith, who again discusses with frankness the price problem, and from the technical aspect by Mr. L. J. Hooley, who records the production of several important new dyes. Dr. Maxted's article, as usual, keeps us informed of the main developments in the nitrogen industry during the year. Mr. Parrish, in a comprehensive review of the heavy chemical branch, again emphasises the need of greater co-operation among by-product interests, and raises the interesting, though at the moment perhaps speculative, question whether synthetic ammonia factories may not some day be replaced or at least supplemented by the bacterial fixation of nitrogen. The articles, too, by Mr. S. J. Tungay on chemical engineering, Dr. Vargas Eyre on the solvents industry, Mr. A. A. Drummond on synthetic resins, Mr. A. B. Bruce on the fertiliser industry, and Dr. Malcolm Dyson on medicinal chemicals are all well worth study. Finally, in the notices of the work of the various chemical societies there is evidence of what these important organisations are doing, outside industrial activities, for the good of the profession and industry in one direction or another.

Books Received

OUTLINES OF QUALITATIVE CHEMICAL ANALYSIS. By Frank Austin Gooch and Philip Embury Browning. London: Chapman and Hall, Ltd. Pp. 206. 8s. 6d.

INORGANIC CHEMICAL TECHNOLOGY. By W. L. Badger and E. M. Baker. London: McGraw-Hill Publishing Co., Ltd. Pp. 228. 12s. 6d.

AN INTRODUCTION TO QUALITATIVE CHEMICAL ANALYSIS AND THE RELATED CHEMICAL PRINCIPLES. D. P. Smith and H. K. Miller. London: McGraw-Hill Publishing Co., Ltd. Pp. 275. 11s. 3d.

COLLOID CHEMISTRY—THEORETICAL AND APPLIED. Vol. II. BIOLOGY AND MEDICINE. By Jerome Alexander. New York: The Chemical Catalog Co. Inc. Pp. 1029. $15.50.

The Calendar

1929 Jan. 3	Society of Chemical Industry (Bristol Section). Joint Meeting with the Chemical Society. "Some Properties of Flame and Combustion." Professor W. E. Garner. 7.30 p.m.	University, Bristol.
7	Society of Chemical Industry (London Section). Joint Meeting with the Fuel Section. "The Action of Hydrogen upon Coal." J. Ivon Graham. 8 p.m.	Burlington House, Piccadilly, London.
7	Institution of the Rubber Industry (London Section): "Factory Organisation in the Rubber Industry Affecting the Conditions of the Worker. F. W. Bennett."	Blackfriars Theatre, Lever House, London, E.C.
8	Hull Chemical and Engineering Society: "Electric Cranes." G. R. Adamson and C. F. Tinker. 7.45 p.m.	Grey Street, Park Street, Hull.
8, 9 & 10	Optical and Physical Societies, Annual Exhibition of Scientific Apparatus.	Imperial College of Science and Technology, London.
9	Institute of Metals (Swansea Section): "Pulverised Coal in Metallurgy." G. E. K. Blythe. 7 p.m.	Thomas' Café, High Street, Swansea.
9	Institute of Fuel: "The Application of Pulverised Fuel Firing for Lancashire Boilers." H. A. S. Gothard.	London.
10	Institute of Chemistry (Manchester Section): "Pregl's Micro-methods of Analysis." H. D. K. Drew.	Manchester.
10	Oil and Colour Chemists' Association: "Nitro-cellulose Lacquers." Bertram Campbell. 7.30 p.m.	30, Russell Square, London.
10	Institute of Metals (London Section): "The Lead Industry." H. C. Lancaster. 7.30 p.m.	83, Pall Mall, London.
11	Society of Chemical Industry (Manchester Section): Short Papers by Members.	Manchester.
11	Institute of Chemistry and Society of Chemical Industry (South Wales Section): "The Preparation of Coal for Market." 7.30 p.m.	Thomas' Café, High Street, Swansea.
11	Chemical Engineering Group: "The Relative Safeties of Mild and High Tensile Alloyed Steels under Alternating and Pulsating Stresses." Professor B P. Haigh.	London.

To the many loyal friends who welcomed the Chemical Age on its establishment nearly Ten Years ago:

To the hosts of new friends the journal has made in that period and still continues to make, both at home and overseas:

To the Great Industry which it seeks to serve and whose continued developments it is proud to record:

To the Contributors, Readers, and Advertisers whose collective & unfailing support have made its success possible:

The Proprietors, Editor, & Publisher of The Chemical Age offer their sincere acknowledgments, together with all good wishes and hopes for their Prosperity & Progress throughout 1929.

Notable Chemical Events of the Past Year

A Period of Consolidation and Expansion

This article is in the nature of a résumé of the more interesting and important events which have taken place in the chemical world in the past year. In addition to matters of an actual industrial nature, it deals also with Government inquiries, with points of personal interest, and with many other details.

THE year 1928 has been marked in British chemical industry by consolidation and expansion. One of the best criteria of the situation is afforded by the Board of Trade returns, which, month by month with hardly a check, have shown a steady increase of strength. The last available returns, those for November, indicate that in the eleven months ended November 30, 1928, imports of chemicals, drugs, dyes and colours were valued at £14,091,980, an increase of £101,126 on the corresponding period of 1927, and of £29,136 on 1926; exports were valued at £23,383,791, an increase of £1,978,216 on 1927 and of £3,186,248 on 1926; while re-exports were valued at £945,430, an increase of £7,633 on 1927, and of £28,306 on 1926.

Combination and Rationalisation

The tendency, first demonstrated in the formation of the I.G. Farbenindustrie A.-G., for single units in the chemical industry to coalesce forming larger organisations capable of dealing with every aspect of chemical manufacture, has continued to show itself throughout the year. In this country, the combination into a single body of the various companies which in 1926 were formed into Imperial Chemical Industries, has proceeded steadily. A very appropriate sign of the times is the completion of the new headquarters of the company, Imperial Chemical House, at Millbank, London; while it is reported that a companion building of the same size is also to be erected. I.C.I. has continued to expand by the absorption of various other companies. In May, at the first annual meeting of I.C.I., a profit for the year of £4,567,225, as shown by the balance sheet, before providing for income tax, was announced. In July, the company issued 3,363,855 ordinary shares of £1, and 2,242,570 deferred shares of 10s.

A development of great international importance was the formation, in April, of the Finance Company of Great Britain and America, Ltd., with a capital of £2,040,000, divided into 2,000,000 ordinary shares of £1 and 800,000 deferred shares of 1s. The ordinary share capital is held in equal proportions by I.C.I. and the Chase Securities Corporation (of the United States).

A fusion was announced between two large chemical companies in the United States, namely, the E. I. du Pont de Nemours Co. and the Grasselli Chemical Co.

The Dead Sea Concession

The question of the production of potash, etc., from the Dead Sea continued to command great interest during the year. In December, 1927, the concession was awarded in principle to Major Tulloch and Mr. Novomeysky, subject to terms satisfactory to the Governments concerned being agreed upon. Questions with regard to the matter were repeatedly put in the House of Commons, without, however, eliciting any further information.

Dyestuffs

The total output of dyes in Great Britain in 1927 (published in June, 1928), based on returns furnished voluntarily to the Dyestuffs Development Committee by the principal British manufacturers, was stated to be 39,551,756 lb. (as compared with 30,292,000 lb. in 1926), and was the largest total of production attained in this country. The total was divided between the different classes as follows:—Direct cotton colours, 5,615,607 lb.; acid wool colours, 6,233,179 lb.; chrome and mordant colours (including Alizarine), 7,502,229 lb.; basic colours, 2,014,806 lb.; sulphur colours, 7,117,233 lb.; vat colours (including Indigo), 8,818,923 lb.; dyestuffs for lake making, 1,138,375 lb.; oil, spirit and wax colours and miscellaneous, 1,111,404 lb.

The Dyestuffs (Import Regulation) Act

During the year, there was much interest in the approaching end of the Dyestuffs (Import Regulation) Act of 1921. Passed to run for 10 years, this Act will, under present law, expire in 1931. The question as to whether the Act will be allowed to expire, or whether it will be renewed, and if so, in what form and with what modifications, has been widely discussed. In the first eleven months of the year, the number of applications made for licences to import dyestuffs was 6,882, of which 6,438 were granted. The corresponding figures for the full year 1927 were 7,467 and 6,753 respectively.

Hydrogenation and Low-Temperature Carbonisation of Coal

The production of oil from coal continued to receive much attention. The I.G. have been for some time producing oil by the hydrogenation of lignite, but the hydrogenation of hard (bituminous) coal, according to reports from Germany, still continues to present difficulties. In this country, research on the hydrogenation of coal was continued by the Fuel Research Board and by I.C.I. The last report of the Fuel Research Board indicated, however, that the actual examination of the commercial aspects of coal hydrogenation was being left to I.C.I. (who have a controlling interest in the British Bergius Syndicate), while the Fuel Research Board would devote itself to the investigation of the fundamental chemical reactions involved.

No remarkable new developments in low-temperature carbonisation occurred during the year. A point of some importance, however, was the increasing interest shown by gas companies in the matter. In November, it was announced that an agreement had been concluded between Low Temperature Carbonisation, Ltd., and the South Metropolitan Gas Co., whereby the latter undertook the manufacture, under license, of smokeless fuel (Coalite) by the British Parker system. A Coalite plant capable of distilling over 2,000 tons of coal per week was to be erected at the West Greenwich works of the gas company.

Fuel Conferences and Reports

In the period September 24-October 6, the World Power Conference (Fuel Conference), attended by delegates from countries all over the world, was held at the Imperial Institute, London. The Second International Conference on Bituminous Coal was held at Pittsburgh, United States, in the period November 19-24, under the auspices of the Carnegie Institute of Technology. In September, the Fuel and Power Committee (appointed by the Board of Trade in 1926, to consider and advise upon questions connected with the economic use of fuels and related matters) issued its report.

Honours and Distinctions

In June, Sir Alfred Mond, chairman of I.C.I., was raised to the peerage, becoming Baron Melchett of Landford in the County of Southampton. Other distinctions extended to him included the Fellowship of the Royal Society and the gold medal of the Institute of Mining and Metallurgy, while he was also elected to the presidency of the Chemical Industry Club. The King's Birthday Honours List, which announced Sir Alfred Mond's peerage, also included Mr. D. A. Gracey, superintending chemist at the Government Laboratory (I.S.O.); Dr. J. A. Voelcker (C.I.E.); and

Dr. C. H. Lander, Director of Fuel Research (C.B.E.). Professor R. Willstätter, the eminent German organic chemist, was elected a Foreign Member of the Royal Society; and Sir Robert Hadfield was elected a Foreign Associate of the National Academy of Sciences, Washington.

Professor J. F. Thorpe was elected to the presidency of the Chemical Society; Professor T. M. Lowry to the presidency of the Faraday Society; Dr. A. D. Little to the presidency of the Society of Chemical Industry; Mr. A. R. Hinks to the presidency of the Society of Public Analysts; Mr. F. Scholefield to the presidency of the British Association of Chemists; Sir William J. Pope to the Prime Wardenship of the Goldsmith's Company; Professor S. W. Parr to the presidency of the American Chemical Society; and Dr. E. W. Smith to the chairmanship of the Fuel Section of the Society of Chemical Industry.

Anniversaries which occurred during the year were the jubilee of the formation of the firm of Brotherton and Co., Ltd.; the jubilee of the entry into the dyestuffs industry of Mr. Ernest Hickson, of Hickson and Partners, Ltd.; and the twenty-fifth anniversary of the formation of the Faraday Society.

Medals and Prizes

Medals and prizes were awarded during the year as follows: The Nobel Chemistry Prize for 1927 to Professor H. Wieland, of Munich, for his work on gall acids; the Nobel Chemistry Prize for 1928 to Professor A. Windaus, for his work on the constitution of the sterols and their relation to the vitamins; the Davy Medal of the Royal Society to Professor F. G. Donnan; the Messel Medal of the Society of Chemical Ihdustry to Professor R. A. Millikan, the American physicist; the 1928 Perkin Medal of the Society of Chemical Industy (American Section) to Dr. Irving Langmuir, and the 1929 medal to Dr. C. E. Sullivan; the Meldola Medal of the Institute of Chemistry to Dr. J. H. Quastel; the Perkin Medal of the Society of Dyers and Colourists to Dr. R. E. Schmidt, of Elberfeld; the Dyers' Company Research Medal to Professor F. M. Rowe.

Appointments and Resignations

After filling the post of general manager of the Association of British Chemical Manufacturers with brilliant success from the formation of the Association, Mr. W. J. U. Woolcock resigned, and joined the board of the Mond Staffordshire Refining Co. In his stead was appointed Mr. J. Davidson Pratt. The Ramsay Memorial Chair of Chemical Engineering at University College, London, vacated by the resignation of Professor E. C. Williams, was filled by the appointment of Dr. W. E. Gibbs, hitherto chief chemist to the Salt Union. Ltd.; while the chair of organic chemistry in the same college, vacated by the retirement of Professor J. N. Collie, was filled by the appointment of Professor R. Robinson. Professor James Kendall was appointed to the chair of chemistry in the University of Edinburgh vacated by the retirement of Sir James Walker.

The Hexyl Resorcinol Patent Action

In the early part of the year, the appeal of Sharpe and Dohme Inc. against the judgment given in July 1927 by Mr. Justice Astbury in their action against Boots Pure Drug Co., Ltd., was heard. It will be remembered that the original action was concerned with hexyl recorcinol, Sharpe and Dohme alleging that Boots had infringed their patents in regard to this substance. In his judgment in the original action, Mr. Justice Astbury held that having regard to the prior publications, the step taken by the patentees was not invention, and that, although hexyl resorcinol had in fact never been made until the patentees made it, the patent was invalid for want of subject matter. In the Court of Appeal (before the Master of the Rolls, Lord Hanworth, and Lords Justices Sargant and Lawrence), the appeal of Sharpe and Dohme against the latter judgment was dismissed with costs.

The Calcium Biphosphate Inquiry

A complaint was made that calcium biphosphate (of baking powder quality) had been improperly excluded from the list of articles chargeable with duty under Part I of the Safeguarding of Industries Act. An inquiry into this complaint was held before a committee consisting of Mr. A. A. Hudson, K.C. (the Referee), Professor F. G. Donnan, and Professor J. F. Thorpe. The complaint was made by A. Boake, Roberts and Co., Ltd., supported by the Association of British Chemical Manufacturers and Albright and Wilson, Ltd., and it was asked that the substance in question be included in the list. There was opposition by the British Chemical and Dyestuffs Traders' Association, Chas. Page and Co., Ltd., and David T. Boyd and Co., Ltd. At the end of the inquiry, the committee decided that calcium biphosphate of baking powder quality was a fine chemical. and should be included in the Board of Trade list of dutiable substances. As a result, the substance in question has been added to the list by the Board of Trade, and has been chargeable with duty since June 4, 1928.

Miscellaneous

Members of the Institution of Chemical Engineers and of the Society of Chemical Industry visited Canada and the United States, and the latter body held its annual meeting in New York. The Ninth Congress of Pure and Applied Chemistry was held at The Hague in July. Chemicals and chemical plant formed a prominent feature of the British Industries Fair held in February.

The first report of the Joint Advistory Committee on River Pollution was issued in September. The Board of Trade published a preliminary report on that part of the Third Census of Production, 1924, dealing with the chemical and allied trades. A commission was appointed to revise the British Pharmacopœia.

A committee was appointed by the Government to inquire into the dangers to health arising from the use of lead tetraethyl in motor spirit. The committee issued an interim report in July.

Obituary

Among those who died during the year were the following: Mr. W. J. Asquith; Mr. W. C. Barclay; Professor A. A. Breneman; Dr. T. T. Best; Professor R. A. Berry; Mr. J. Bristow; Mr. W. G. Blagden; Dr. Emile Bronnert, the eminent authority on artificial silk; Mr. E. J. Clark; Mr. F. C. Clayton; Professor T. Curtius, the German organic chemist; Mr. A. J. Daish; Mr. William Dancer; Mr. William Du Pont, of Wilmington, Delaware; Mr. H. Leaton Edwards, of Lever Brothers; Mr. Alexander W. Fyfe, of the British Dyestuffs Corporation; Mr. M. Garside; Professor W. W. H. Gee; Mr. S. M. Gluckstein, of J. Lyons and Co.; Mr. W. S. Gray; Dr. E. C. Grey, formerly professor of chemistry in the University of Cairo; Mr. Wilfrid Irwin; Mr. J. H. B. Jenkins; Mr. W. E. Lea; Professor R. Lepetit; Dr. Martin Liebert, of Spencer, Chapman and Messel; Professor H. A. Lorentz; Mr. E. C. R. Marks, patent agent; Mr. G. A. Marsden; Mr. E. J. H. Midwinter; Mr. E. G. Nelis, of the Chemical Catalog Co.; Mr. W. H. Nichols; Mr. D. O'Connor; Mr. C. L. Parker; Dr. F. M. Perkin; Mr. Peter Robertson, editor of *The Gas World*; Mr. Thomas Robinson; Dr. F. Raschig, the German organic chemist; Professor Theodore W. Richards, of Harvard University; Mr. Edouard Sandoz; Professor G. Schultz, of Munich, an authority on dyestuffs; Mr. R. P. Sellon, of Johnson, Matthey and Co., Ltd.; Professor E. F. Smith (of the United States); Dr. A. J. Walker; Mr. J. H. Watterson; Mr. Edmund White, managing director of Hopkin and Williams, Ltd.; Mr. W. Windus, of the United Alkali Co.; and Professor T. Zincke, the German organic chemist.

British Chemical Industry in 1928

By Brig.-Gen. Sir William Alexander, K.B.E., C.B., C.M.G, D.S.O., M.P.

As an introduction to the many articles that follow, this by Sir William Alexander, M.P., is valuable, as setting out with a firm historical and critical touch, and in just the right perspective, the essential characteristics of the year. 1928 is described as a year, not only of accomplished recovery, but of accelerated progress. 1929, it is confidently predicted, will be distinguished by a greatly increased application of science to industry.

A JUST appreciation of the importance and of the achievements of 1928 demands some brief consideration of its time context—looking backward and forward.

Looking backward to historic years, we had in 1918–20 a short-lived post-war boom of speculative trade ; in 1921, a devastating trade slump, undermining confidence and paralysing effort ; in 1922, lowered costs and harder work, contending against the vagaries of foreign currencies and the disturbance caused by the liquidation of accumulated stocks ; in 1923, a small but definite advance towards trade recovery and normal conditions ; in 1924, increased financial stability, leading to large business ; in 1925, the largest volume of trade ever known ; in 1926, the coal strike ; in 1927, a recovery from its ill effects, together with important amalgamations of industrial interests and effort in production and research ; also the beginnings of a general recognition of the importance of coal as a basic raw material.

Looking forward, not as a prophet, but as one wise with the certitude of 1928, it is abundantly clear that if normal conditions continue, 1929 and succeeding years will be distinguished by the application of science to industry in all its branches with a skill and intensity hitherto unattained.

A Year of Recovery

In this context, 1928 becomes significant and takes its place as a year not merely of accomplished recovery from a sequence of unsettling and disabling years, but as one of real progress at an accelerated pace, a progress due to the elimination, in part at least, of wasteful effort and competition and to the establishment of an effective co-partnership between scientific advance and industrial technique.

British Chemical Industry is showing a much readier response than it once did to the needs and demands of the moment, and is more alert in accepting the hint of circumstances. This is reflected in the nature and the volume of chemical trade during the past year. To a remarkable degree its increase is due to the newer industries, such as artificial silks, lacquers and solvents, alloys, safety glass, films, motor fuels, fertilisers, foods, and modern methods of pre-treating coal, the latter small as yet in their effects, but not negligible in possibilities.

Every one of these industries is based on scientific investigation, sometimes purely academic in its initial stages, more often to-day dictated from the start by known industrial requirements. This new orientation is reflected in no uncertain manner in the character of the very numerous company ventures of the past year, some of them admittedly highly speculative.

Nearly all of them claim to exploit an invention or new process based on some reaction of organic synthetic chemistry or on some skilful use of the results of physical research. This, indeed, is the keynote of the year under review.

Some Notable Achievements

Turning to specific cases, there is to be recorded the commercial production of synthetic methyl alcohol at Billingham. This is one of the first fruits of the enterprise of the powerful group known as Imperial Chemical Industries, disposing of great resources in men and plant. About half the large staff at Billingham consists of university graduates specially chosen for high pressure catalytic work and research in this and kindred directions. It is very heartening for the chemical industry of the country to know that in enterprise and skill we are not lagging behind America and Germany.

Acetic acid and acetone, hitherto mainly imported, have now reached the stage of home production from ethyl alcohol. Butyl alcohol and solvent esters are now being made synthetically. It is significant to realise that hundreds of tons a year are being made of such a one-time laboratory production as butyl acetate.

The Distillers Co. has plants in course of erection for the production of solvents, and it has founded and equipped a research laboratory at Carshalton. The wood distillation and fermentation industries will become less and less important as synthetic methods are developed.

In the important field of fertilisers, development has taken place based on the availability of synthetic ammonia and the production of mixed and complete fertilisers. The education of the farmer is proceeding more intelligently than formerly, and he is being helped by the introduction of special schemes of purchase and by stabilised prices.

In dyestuffs, steady progress has been made, and here, again, the advantages of pooling resources and co-ordinating research are evident. This country was weakest in the production of the fast vat dyes, but the range has now been extended and the production of known and new colours is encouraging and greater than is generally realised. The consolidation of the position which is taking place is of great importance in its bearing on the new position which will arise with the expiry of the Dyestuffs Act in 1930. The technique of dyestuffs chemists, which, in organic chemistry, is of the highest, is being gradually utilised in directions other than colour making, to the advantage of chemical industry as a whole.

What Safeguarding Means

Some of the newer industries have been assisted by the Key Industries Duty and by a measure of safeguarding and they have undoubtedly benefited. Safeguarding should be judged on its merits and quite apart from purely political considerations. Safeguarding is not, and is not meant to be, a crutch for cripples, but rather a means of teaching a youngster to walk. There are several cases in which the help has led to increased production, which in turn has caused such a lowering of costs that strength and independence have been achieved.

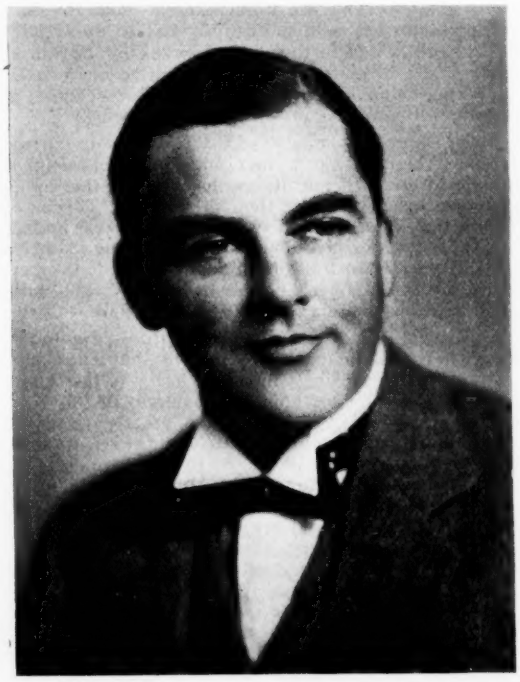
Such industries, all of them closely connected with the chemical industry, are those manufacturing motor cars, rubber tyres, earthenware crockery, etc. The success achieved has led foreign firms to put up factories in this country, thus introducing fresh capital and increased opportunities for work.

There is great, but perhaps lessening, depression in the great textile industries using wool and cotton. In the cotton industry, steps are being at last taken towards rationalisation, which really means a common-sense facing and handling of an admittedly complex and difficult problem.

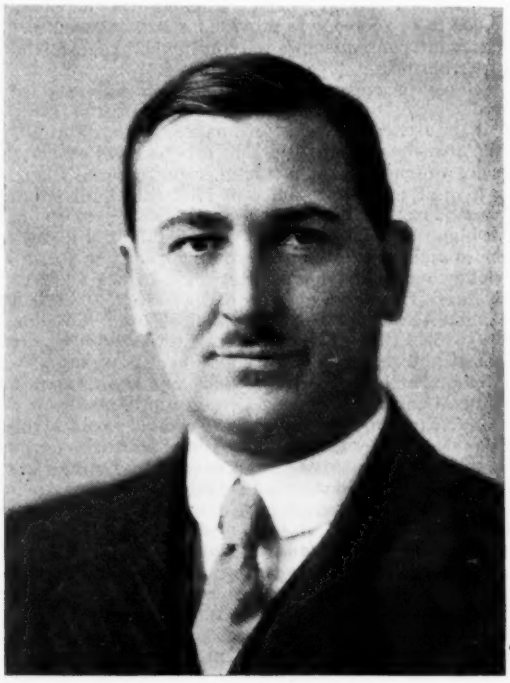
There is a crisis, too, of almost tragic intensity in the mining industry. It would be out of place to discuss the measures taken or proposed for dealing with a situation due to causes some external and beyond control, while some are internal and remediable.

Brig.-Gen. Sir William Alexander, M.P. for the Central Division of Glasgow.

Mr. H. Sutcliffe Smith, Chairman of the Colour Users' Association.



Mr. F. C. O. Speyer, General Manager of the British Sulphate of Ammonia Federation and of Nitram, Ltd.



Mr. J. Davidson Pratt, General Manager of the Association of British Chemical Manufacturers.

New Coal Technology

Of importance, however, to chemical industry is the growth of interest in 1928 in methods for the processing of coal by methods other than the high temperature methods of the coke and gas industries. The World Power Conference, recently held in London, gave a good deal of attention to these newer methods. The processing of coal must inevitably tend to become part of chemical industry. There are very many processes for the low temperature carbonisation of coal, and the economically sound ones will emerge in course of time. In the meantime more research is needed in the case of low temperature coke as an industrial fuel, whether as such or in a pulverised state. The by-products, and particularly that known as primary tar, are being examined, and it is significant that some of the tar distilling firms have equipped a special research laboratory to deal with the material as one certain of increasing importance, and one which cannot be dealt with satisfactorily by existing methods. The Germans are to-day carrying out the hydrogenation of primary tar, and it behoves us not to forget the lesson taught by the German dye industry, largely based, at the beginning, on English tar as its raw material.

The Heavy Chemical industries continue to expand at home and abroad, and development of the newer industries is having a beneficial effect.

In summary, the past year has demonstrated that union and collaboration mean strength, that new industries dependent on chemistry are developing favourably, and that chemists and the chemical industry have great opportunities, which, if seized, will mean success and prosperity in 1929.

Imperial Chemical Industries: A Survey of 1928

Important Developments at Home and Overseas

The following specially contributed article on the developments of Imperial Chemical Industries, Ltd., during the year gives a clear and concise account of the general policy of this great organisation, its achievements up to the present, and its contemplated expansions in the near future.

THE units comprising Imperial Chemical Industries are related not only as producers of like commodities, but also as consumers of each other's products, thus providing exceptional opportunities for the exercise of efficiency and economy in the purchase of raw materials, concentration of manufacture, distribution to customers, and transport services.

The following outline of the more important developments during 1928 indicates the progress made in these and other directions.

Administration

In the course of the year Lord Weir, Lord Birkenhead and Mr. E. J. Solvay joined the directorate.

The authorised capital of the Company was increased by £10,000,000 to £75,000,000 to provide for large expenditure on capital account, consequent on the continuous expansion of the Company's business.

Appreciable progress has been made in the exercise of executive control over the companies comprising Imperial Chemical Industries in respect of finance, labour, and all the essentials of management. Further progress will ensue when the central organisation gets together in Imperial Chemical House—a most up-to-date office in Millbank, built specially to accommodate the head office staff now housed in many different buildings. The concentration of staff at Millbank has commenced and is expected to be complete early in 1929.

The following companies in which I.C.I. had a direct or indirect interest have been acquired: Cassell Cyanide Co., Ltd.; Union Acid Co., Ltd.; Tees Salt Co., Ltd.; Casebourne and Co. (1926), Ltd.; Oliver Wilkins, Ltd.; and also certain metal companies referred to in a subsequent paragraph.

A development of prime importance was the formation of the Finance Company of Great Britain and America with a capital of £2,040,000, the whole of the ordinary capital being held in equal shares by I.C.I. and the Chase Securities Corporation, New York. Its main object, as defined by Lord Melchett, is "to bring the great financial and capital strength of America to the use of industrial purposes in this country, the Empire, and the world."

Plant and Products

Alkali Products.—The reorganisation of certain plants on the most modern lines continues with consequent improvement on the processes. Extensions of manufacturing capacity for ammonia soda and caustic are being pushed forward to meet the growing demand, and less efficient plants are being closed down.

Chlorine and Chlorine Products.—There is a definite increase in the demand for liquid chlorine—chiefly for the artificial silk trade—and synthetic HCl is to some extent replacing acid made from salt and sulphuric acid. To meet this demand, I.C.I. have increased their electrolytic plant, and further extensions will be brought into operation next year.

Sulphuric Acid.—Throughout the country plant capacity is far in excess of requirement, and costs of production are therefore burdened with heavy charges for upkeep of idle plant and interest on its capital value. I.C.I. are taking steps to bring capacity more nearly into line with production by concentrating manufacture in as few centres as possible, scrapping surplus and worn-out plant, and, where necessary, building new and up-to-date plant, with a view to increased efficiency and reduction of costs.

In carrying out this reconstruction and consolidation of manufacture, due regard is being had to the growing demand for high strength and non-arsenical acid.

Nitrogen.—During the past year the new 165 tons-a-day ammonia unit has been successfully started up at Billingham, and the erection of further extensions is far advanced. The development of derived products, such as nitro-chalk, nitric acid, ammonium nitrate, ammonium bicarbonate and anhydrous ammonia has proceeded simultaneously.

Heavy Organic Chemicals.—I.C.I. continues to pursue its aim to render the British consumer independent of foreign supplies of heavy organic chemicals, and has plants either in operation or under construction for their production. Glycol, which is used in the explosives industry as an anti-freeze and generally as a substitute for glycerine, is already being made. A great deal of research work has been and is being done on synthetic resins for the lacquer and paint industry, and large scale manufacture is contemplated at an early date.

Explosives.—This year has so far witnessed no outstanding change in the manufacture of explosives, but a new ammonium type of low-freezing gelatinous explosive is just about to be put on the market for home customers. In this connection, advantage has been taken of the greatly increased home manufacture of ammonium nitrate, and the resultant benefit in cost of production will be passed to the customers. In other words, explosives of the gelatine dynamite and full-strength gelignite types will be available at a reduced figure. Although they will not possess as great a resistance to the effects of moisture as the old type, these new explosives should nevertheless prove satisfactory substitutes as long as reasonably rapid consumption obtains.

The production of large quantities of synthetic ammonia by I.C.I. in this country has naturally led to the utilisation of this raw material in the manufacture of nitric acid required for explosives. A large plant has been erected in one of the Scottish factories and will shortly be in operation.

Dyestuffs.—The following, amongst other additions to the range of colours, have been made during 1928:

Caledon Brown R and G, very important vat dyes; Dispersol Diazo Black A paste, Dispersol Fast Yellow A, Dispersol Fast Orange A, and Dispersol Fast Red A (artificial

silk dyes); Solochrome Red E.R; Toluylene Orange G; Chlorazol Orange Brown R; Monolite Rubine BN, Chlorazol Rose B, and Chlorazol Fast Scarlet 8BS.

Research

Prime importance is attached by the Chairman and his executive to continuous research. The expenditure of I.C.I. in its laboratories for this purpose exceeds one-quarter of a million pounds a year. In addition, the company gives adequate support to and maintains close touch with research activities of universities and scientific institutions.

Selling Organisation

Prior to the formation of I.C.I. each of the merging companies had its own selling organisation and its range of agents, and the business of each in the main was limited to the products which it manufactured. Consequent upon the amalgamation of interests, sales control was centralised at headquarters and, coincident with that centralisation, area offices were established covering the United Kingdom, the Irish Free State, and Northern Ireland, each being responsible within the area allocated to it for the entire sales of chemicals and dyes within that area. For the more efficient staffing of these offices, salesmen personally acquainted with the respective districts and with a knowledge of chemicals were given special training in dyestuffs and *vice versa*. In this way, a very much improved service to customers has been built up, eliminating considerable trouble and delay in obtaining supplies and ensuring the prompt execution of orders.

In place of four separate organisations for the purchase of raw materials, stores, and plant, one central purchase authority has been established for the whole of the organisation, and this has keyed up the efficiency of the purchasing service and effected appreciable economies.

Transport control has also been centralised, thereby ensuring expert assistance on all transport questions for the entire organisation.

Repeated assurances have been given that it is no part of the policy of the directors to take advantage of the position of the company to increase prices, and evidence of their sincerity is apparent in the appreciable reductions that have been effected in the course of the year in the price of the principal products of the company. In chemicals alone, reductions were effected in the price of over 14 principal products. We have thus a practical demonstration of the benefits which flow from an amalgamation of interests such as that comprised in Imperial Chemical Industries.

I.C.I. is interested in lighting and lighting equipment through Lighting Trades, Ltd., and the company's position in this branch of industry has been consolidated by the acquisition of the Welsbach Company.

Imperial Developments

The imperial aspect of the company was clearly expressed by the chairmen of the merging companies in the following words:

> The company has of deliberate purpose been given the title of Imperial Chemical Industries, Ltd. The British Empire is the greatest single economic unit in the world, one in which every patriotic member of the great British Commonwealth has a personal interest. By linking the title of the new company to that unit, it is intended to lay emphasis upon the fact that the promotion of imperial trading interests will command the special consideration and thought of those who will be responsible for directing this new company. The participating companies already enjoy a world-wide trade; their merchanting and manufacturing operations therefore extend throughout the British Dominions overseas; and it will be the avowed intention of the new company, without limiting their activities in foreign overseas markets, specially to extend the development and importance of the chemical industry throughout the Empire.

Australia.—Considerable attention has been devoted to Australia and New Zealand. The potential developments of I.C.I. interests there were fully inquired into from the technical, commercial and financial aspects, and arising from reports submitted, a member of the I.C.I. Board has proceeded to Australia for the purpose of consolidating and developing these interests.

Meantime, factories are in course of erection for the production of leather cloth, such as Rexine, and Duco cellulose lacquers. Additional interests have been acquired in the fertiliser industry.

For the encouragement of the study and application of nitrogen to cereals and pasture, a grant of £2,000 has been made to the Waite Institute of Adelaide.

Samples of coal from Australia have been tested and reported upon favourably as raw material for the manufacture of oil, and it is the intention of I.C.I. to co-operate with Australian interests in developing in Australia the production of synthetic oil and motor spirit.

Foreign Interests

The interests of I.C.I., whilst directed primarily to development within the British Empire, are world-wide, and whenever and wherever opportunities present themselves, prompt advantage is taken for the retention of existing trade and the development of legitimate business.

Appreciable progress has been effected in the organisation of the company's business abroad. Independent companies for the handling of the company's products have been established as follows:—Imperial Chemical Industries, S.A. Comercial e Industrial (Argentina); Cia. Imperial de Industrias Chimicas do Brasil; Cia. Imperial de Industrias Quimicas de Chile; Imperial Chemical Industries, S.A. Peruana Comercial e Industrial.

Commissions have visited all important overseas countries for the furtherance of the company's interests.

Fertilisers and Agricultural Research

Mention has already been made of the remarkable progress in the output of fertilisers at Billingham. The requirements of agriculture have been and are being closely studied at home and abroad. In connection with the intensive system of grassland management, demonstrations have been carried out at 150 centres, and records are being taken to ascertain the economic results of the trials. The application of nitrogenous fertilisers for securing early grass formed the subject of experiments at 86 centres. In 30 countries overseas and in many districts of each country, trials have been conducted. In fact, continuous experimental and research work is conducted in relation to the selection and application of fertilisers for specific agricultural purposes. In this connection, Jealotts Hill farm is used for experimental work and is in course of being equipped as a research station.

In order to provide a closer link between manufacturers and users of fertilisers, a new company (Scottish Agricultural Industries, Ltd.) is being formed in Scotland by I.C.I., associated with several well-known fertiliser manufacturers, namely: Alexander Cross and Son, Glasgow; Cross Chemical Co., Falkirk; J. and J. Cunningham, Leith; John Miller and Co., Aberdeen; Charles Tennant and Co., Carnoustie; and Daniel Wylie and Co., Ayr.

This new organisation will provide farmers with proper fertilisers for all their needs at the cheapest price and on the best possible credit terms.

Metal Group

The disability under which the company laboured consequent upon its inability to undertake composite orders for hot-rolled as well as cold-rolled metal was overcome by the acquisition of Elliott's Metal Co. and British Copper Manufacturers. Unification of control has been established, and the company's influence and interests in the non-ferrous metal industry appreciably strengthened.

Staff and Labour

Imperial Chemical House, Millbank, is one of the new landmarks of London. The architecture is striking, and the building embodies the latest scientific developments in office construction and equipment. The comfort and general interests of the staff have been provided for even to the extent of arrangements for sunlight treatment.

The headmasters of the leading public schools have collaborated in the selection of candidates from public schools for future employment in I.C.I., and a number of boys have been chosen in accordance with provisions of the scheme devised for the purpose.

Special attention has been given to the co-ordination of the labour policy of I.C.I., and appreciable improvements have been effected in conditions affecting employees, *e.g.*:

Share Investment Scheme.—Employees 21 years of age and over, who have completed one year's service, are eligible. Payment may be made by instalments over two years. The

shares are made available at 2s. 6d. below the average market price at the time of purchase, dividend rights become effective with the first payment, and in the event of death supervening before payments have been completed certificates for fully paid shares are handed to the employee's legal representative. The number of employee shareholders has increased from 2,000 at the end of the first month to about 5,500, and the shares from 103,500 to well over half a million.

Staff Grade Scheme.—This scheme was introduced as from June 1, 1928, and all workers who have completed five years' continuous service with any of the subsidiary companies of I.C.I. and who are 26 years or over are eligible for promotion. Workers promoted to the Staff Grade will receive a month's notice of suspension or termination of employment. In the event of absence through sickness the staff wage (less any State insurance benefits that may be payable) is paid up to a maximum of six months in any year. Similarly, in the event of absence from work owing to an accident arising out of and in the course of their employment, Staff Grade workers receive, in addition to the legal compensation that may be due to them, such additional amount as may be necessary to make up their compensation to their staff wage, for a maximum period of six months in respect of any one accident.

Holidays with Pay.—All employees with twelve months' service, subject to satisfactory timekeeping, are granted a week's holiday with full pay.

Coincident with this, a scheme for "Holiday Tours Abroad" was organised at a low inclusive cost, supervised by I.C.I. representatives, and met with a most encouraging reception.

Foremen's Pension Fund.—A fund for the provision of pensions on retirement to foremen and forewomen was established as from the beginning of June, 1928, on the basis of joint contributions by the company and the participants. Foremen and forewomen contribute 5 per cent. of their pay to the pension fund; the company contributes payments equivalent to 5 per cent., and in addition makes payment equivalent to 2½ per cent. of the pay of foremen for the purpose of maintaining a Widows' and Orphans' Fund. The company also paid into the fund the necessary sum of money to cover the years of service prior to June 1, 1928, both in respect of employers and employed.

The minimum pension for a foreman is £120 per annum, after 40 years' service, and for a forewoman £65 12s. 6d. per annum, after 35 years' service. The minimum pension, in any circumstances, subject to 10 years' service, is £52 for a foreman and £40 for a forewoman.

At the present time there are 1,083 members, of whom 1,065 are foremen and 18 are forewomen.

Retirement of Employees aged 65 and over.—A suitable scale of pensions and/or gratuities has been inaugurated in respect of employees aged 65 and over, whose length of service ranges from 15 to 35 years.

In the comparatively few cases where workers under 65 years of age have unfortunately had to retire from the company's service on account of a permanent breakdown in health, these have been dealt with on compassionate grounds, and pensions or allowances have been granted on a generous basis.

Works Councils.—Satisfactory progress has been made in the establishment of Works Councils, in accordance with the approved scheme which is intended to provide a direct link between the board and the individual employees at the various works.

Employees number about 47,000, and harmonious relations—an outstanding feature of the pre-merger history of the constituent companies—continue to exist. Relations with trade unions have also been good, and in every instance where questions have arisen they have been adjusted on an equitable basis.

Recreational Facilities.—New schemes have been provided or are in course of being completed at 10 factories. These include the provision of grounds for Association football, Rugby football, cricket, hockey, lawn tennis, bowls, etc., with the necessary dressing room accommodation, together with social halls, comprising billiard rooms, card rooms, dancing and concert halls.

In addition thereto, considerable progress has been made with the improvement of existing recreation facilities at the works of constituent companies.

I.C.I. Magazine.—The introduction of the *I.C.I. Monthly Magazine* was well received and had to be enlarged from 64 to 120 pages. Pensioners of the company are provided with a copy gratis each month. The sales to employees continue to increase, the figure for last month being 36,000 copies.

Direct contact with provincial staffs and employees has been maintained by a series of visits by the chairman, directors and departmental heads, and it is understood to be the intention to continue such visits.

British Chemical Industry during the Past Year

By J. Davidson Pratt, O.B.E., M.A., B.Sc., F.I.C.

(General Manager of the Association of British Chemical Manufacturers.)

The following comprehensive survey of British chemical industry during the past year, by the General Manager of the Association of British Chemical Manufacturers, indicates that while no section has gone back, many sections have gone distinctly forward. Of particular interest is the detailed evidence of the advances made by fine chemical manufacturers. In the section dealing with medicinal or therapeutical products, it will be noted that while the commercial production of synthetic Vitamin D was first achieved in this country, its adoption in Germany, especially in children's hospitals, already far exceeds its use here.

General

In this article it is proposed to give a brief review of the chemical industry in the more restricted sense of the term. No reference will be made to those sections of the industry which, while using chemical products and methods and generally included in any comprehensive definition of the chemical industry, are not primarily engaged in the manufacture of chemicals in the popular connotation of the term. Thus, no reference will be made to the soap, explosives, artificial silk, petroleum, and similar industries.

Any attempts to give statistical data regarding the progress and trade of the industry are handicapped by two factors; firstly, the lack of reliable figures for production, except in a very few cases; and, secondly, the difficulty of obtaining export and import figures in a sufficiently sub-divided form to enable really accurate deductions to be drawn from them. There is another difficulty due to the fact that at the time of writing, the Board of Trade import and export data are available only for the first ten months of 1928. It has, therefore, been necessary to base the 1928 estimates on the figures for the first ten months, and to assume that there will be the same proportionate increase for the rest of the year as there was in 1927. It is not expected that this will vitiate any comparison which is made as to the state of trade in 1927 and 1928.

If 1924 is taken as 100, the Board of Trade estimates indicate that the index of production for 1928 for the chemical and allied trades will be between 105 and 106, being perhaps a little higher than in 1927, when the index was 105.2. The term "Chemical and Allied Trades" includes, according to the Board of Trade, the production of heavy chemicals, explosives, synthetic dyes, ammonium sulphate, sulphuric acid, matches, soap, and the refining of petroleum. Certain of these do not fall within the restricted definition of the chemical industry to which reference was made above and since information is not available as to how this index figure was obtained, it is impossible to say definitely how the production of chemicals in the restricted sense has varied in the past two years. It appears certain, however, that the overall production is, if anything, rather greater for 1928 than for 1927.

During 1928, the Home trade in chemicals has been on the whole good, in spite of the depressed condition of certain of the great chemical consuming industries such as iron, steel,

and textiles. Further, there has been a welcome increase in the export trade. The export value for chemicals, drugs, dyes and colours for 1927, as shown by the Trade and Navigation reports, was some £23,000,000 (representing just over 3 per cent. of our total exports). The 1928 figures are confidently expected to be about 10 per cent. higher. Imports in 1927 totalled some £15,000,000 and are expected to be slightly less in 1928. This represents just over 1 per cent. of our total imports. About 7 per cent. of chemical imports are re-exported.

The increased export figures give cause for satisfaction, since this increase has taken place in spite of restricted markets and keen competition due to the post-war development of chemical industries in many other countries. The strong progressive development of the British Chemical Industry on sound scientific lines has made it possible to manufacture new products, improve the quality and reduce the price, and so capture foreign markets.

Another pleasing feature is the steady growth of co-operation between science or perhaps more correctly academic science and industry. An important development in such co-operation has been the formation by Imperial Chemical Industries of a Research Council which should assist materially in bringing pure and applied chemistry closer together for the general good.

Heavy Chemicals

The Heavy Chemical Section of the industry is being described in another article, so only a very brief reference to it need be made here. British heavy chemicals have long been held in esteem all over the world, and the achievements of the past year have enhanced this reputation. New and improved methods of manufacture have been successfully developed, quality has been improved, and there has been a reduction in price, a very important consideration for all branches of industry that use these chemicals. Home trade has been good in spite of the general industrial depression. The export trade has increased as regards quantity ; but it will probably show a slight falling off in value as compared with 1927 owing to the price reduction mentioned above. Ammonium sulphate is not included in this comparison. Though the position is by no means unsatisfactory, many plants are still working below full capacity, and a revival of activity in other sections of British industry will benefit the production of heavy chemicals.

Since the output of sulphuric acid has in the past been regarded as an index of general prosperity, a few notes on this subject may be of interest, even though sulphuric acid no longer retains its former value as an index.

It is satisfactory to know that the 1928 figures have so far been higher than in 1927. For the twelve months ending September 30, 1928, the output was 908,000 tons, calculated as 100 per cent. sulphuric acid, as compared with 846,000 tons during a similar period in 1927. The 1928 output is approximately 10–15 per cent. less than the amount of acid manufactured in the year immediately preceding the war. It is, however, one of the highest figures reached in recent years, but unfortunately it represents rather less than two-thirds of the acid which the plant of the United Kingdom is capable of producing.

Sulphuric acid in this country is now being made from pyrites, spent oxide, brimstone, and zinc concentrates. Slightly over 44 per cent. of the acid is made from imported pyrites, and about 21 per cent. from brimstone. With the exception of a very small tonnage of coal brasses, the only raw material produced at home is spent oxide. Of recent years, the amount of spent oxide produced by the gas industry and consumed by the sulphuric acid manufacturer has remained practically constant at about 140,000 tons. This represents about 25 per cent. of the acid made. The amount of acid produced as a by-product in spelter manufacture has now reached the substantial proportion of 9.5 per cent. and is some twenty times the quantity so produced ten years ago. There were no large price changes during the year under review, but there has been a gradual and continuous fall.

As regards technical development, reference only need be made to the successful tests of new forms of catalysers for use in the contact process, and to the successful installation of Bracq Laurent pyrites burners at several works. Less is now heard of the Schmiedel process than was the case a few years ago.

Fertilisers

The position as to fertilisers generally has not undergone any very material modification during the year, although there are signs that this section of the industry has approached a period when there will be many far-reaching developments. The chief interest centres round nitrogenous fertilisers, the world production of which is steadily increasing owing to synthetic manufacture in many countries. While the production of sulphate of ammonia suffered a drop in 1926 owing to the coal strike, it practically completely recovered in 1927. The year 1927 in this case is from July 1927 to June 1928. There has been a very welcome recovery in export trade, the total quantity exported being 302,604 tons, an increase of 120 per cent. over the previous year. Much lost ground has been regained in the overseas markets, especially in China and Japan, where sales have more than doubled. There has also been a substantial increase in consumption in India and Ceylon. Home demands for sulphate of ammonia have also been good and prices have been well maintained, quotations now current for home sales being practically identical with the prices at the end of 1927. Imports of Chilian nitrate of soda for the year ending June 30, 1928, show an increase of about 50 per cent. over the previous year's figure, but the bulk of the increase appears to have been for industrial purposes, since the amount used for agriculture remained round about 35,000 tons.

The market for phosphatic fertilisers is much stronger in tone than it was at the commencement of the year, and it is confidently anticipated that home prices for superphosphate will rise in sympathy with the upward movement which has recently taken place on the Continent. So far as consumption is concerned, it appears to be well established that the demand for the recent harvest season absorbed practically the same tonnage as in the previous year, a fact which must be regarded as very encouraging when it is borne in mind that agriculture was extremely depressed. The import figures for 1928 will, however, be considerably lower than for 1927. The same is true of potash salts, though the difference will not be so great in this case.

The outlook for the industry is much less discouraging than it has been for a long time past, and with the improvement in the position of the farmer there is a general feeling that the fertiliser trade may have seen the worst of the depression from which it has suffered. A recent event of some considerable importance is the amalgamation of six Scottish fertiliser firms to form a new organisation called Scottish Agricultural Industries, Ltd. This new company will be controlled largely by Imperial Chemical Industries, though its capitalisation will be quite distinct from that of the latter. This merger may be regarded as an important step towards rationalisation —for want of a better word—of the fertiliser industry of the country.

On the technical side the production of synthetic ammonia is making steady progress at Billingham, while work is actively in hand on the development of composite fertilisers which should effect considerable economies in transport, in addition to such special fertilising value as they may possess. As a result of this work there has been successfully introduced on the market a new manure called " Nitro-chalk," which is a mixture of ammonium nitrate and calcium carbonate containing nitrogen in both ammonia and nitrate form.

Coal Tar Products

The need for a better utilisation of our national coal resources is now admitted in all quarters and consequently much attention has been given during the year to new or improved methods of dealing with coal. One of the main objects is to produce from it oils suitable for fuels for internal combustion engines in order to make this country less dependent on overseas supplies of natural petroleum. A decided fillip has been given to these developments by the Budget duty of 4d. per gallon on imported hydrocarbon oils. This duty has also come as a boon to the normal production of benzole, the price of which had dropped to an unremunerative level.

The new developments are along two main lines, viz., low temperature carbonisation and hydrogenation. The former has made somewhat greater progress than the latter, and a number of plants are now either in operation or in course of erection. An important problem bearing on the economics of low temperature carbonisation is the utilisation of the tar.

This problem has still to be solved, but research on it is actively in progress in the Government Chemical Laboratory at Teddington, from which some interesting results are already forthcoming. Since this investigation is in capable hands, we may look forward to the future with confidence that uses will be found for this tar which will make the operation of low temperature carbonisation processes a really sound financial proposition.

The hydrogenation of coal and tar has been often in the public eye of late and great claims have been advanced by various inventors for their processes. This country has, however, shown commendable caution by carefully testing the more promising of the processes before proceeding to large scale production. A systematic study of the subject is being carried out on a small experimental scale by the Fuel Research Board, while Imperial Chemical Industries are testing the working of a process on a larger scale at Billingham. This method of progressive development on scientific lines is likely to lead to more fruitful results in the long run than the exploitation on a grand scale of new processes which have not been thoroughly studied and proved sound in every detail.

As regards trade in coal tar products, exports have shown a welcome increase, and the value for 1928 is likely to be about 20 per cent. greater than in 1927. Prices have fluctuated and have generally tended to be on the low side. There has been a serious slump in pitch and prices have reached an absurdly low level. Carbolic and cresylic acids have, however, remained firm and in good demand, while the anthracene position has been somewhat better.

Wood Distillation

The Wood Distillation Industry may be dismissed briefly by saying that its position has been a very difficult one in view of the intense competition to which it has been subjected from two sources, viz., from Canada in regard to acetic acid made synthetically by cheap water power at Niagara, and from Germany in regard to synthetic methyl alcohol and to charcoal and wood spirit produced by the huge syndicated combines of Middle Europe. The synthetic production of methyl alcohol in this country, which is now proceeding at Billingham according to programme, will make the competition still more intense, as will also the manufacture of acetic acid and acetone in the near future by the Distillers Co. at their new factory near Hull. These two chemical ventures will, it is hoped, make this country quite independent of overseas supplies of these three very important products.

Dyestuffs

We now turn to the Dyestuffs Section of the Industry, which has perhaps been more in the public eye in recent years than any other section. The need for a well-established dye industry in this country was proved by the experience of the war in no uncertain manner, but now, only ten years after the cessation of hostilities, the war lessons are beginning to be forgotten, and we find various interests dependent on the dye industry protesting against the continuation of the Dyestuffs (Import Regulation) Act of 1921, to which the present strong position of the British dye industry is due. The reply of the industry to all such critics is such as to convince any impartial investigator that the dye makers have made full use of the protection afforded by the Act in the development of the industry. This is a subject which is likely to enter the realms of acute political controversy between now and the beginning of 1931, when the present Act expires.

The British output of dyes has been steadily increasing, and in spite of a temporary set-back due to the coal strike in 1926, reached a figure of approximately 18,000 tons in 1927, as compared with less than 15,000 tons in 1924. The 1928 figures may be expected to be even higher than for 1927. This is a remarkable achievement, having regard to the recent depressed condition of the British textile trades, which form the main outlet for the dyes. With an improvement in the textile trade—and here a change in fashions may exert a great effect—a still higher output would be assured and could be easily met by our dye factories.

It is gratifying to note that our export trade in dyes shows a steady increase in spite of the dye industries which have been started in so many countries since the war, and the serious competition in other foreign markets. The 1927 exports totalled nearly 8,300 tons valued at £752,859, while the 1928 figures promise to be about 20 per cent. higher. The imports have remained steady in value for the past few years, though there has been a small increase in quantity. The 1927 imports were 2,000 tons, valued approximately at £1,000,000. Thus it will be seen that less than 20 per cent. of our home consumption of dyes is imported, whereas in 1913 80 per cent. came from abroad.

The restriction in output referred to above, has, of course, militated against price reduction; but in spite of this there has been a steady fall in the cost of most dyes. The range of dyestuffs made in this country may now be regarded as sufficient to meet all practical requirements and this is a high tribute when it is remembered that the uses are manifold and range from textiles to foodstuffs. In quality British dyes compare favourably with those of any competitor, as is proved by the fact that there have been quite large exports of British dyes to Germany in cases where the British quality was better than the German.

Research work, which is the real basis of any dye industry, has been well maintained in all branches, and its results are such as completely to dispel any fears, should such still exist, that this country is behind Germany in that respect.

Good progress has also been made in the manufacture of the many intermediates which the present-day dye industry requires, and in the development of accelerators and anti-oxidants for use in the rubber industry; the latter are still being used only in a very experimental way, but they give promise of great utility and development.

Fine Chemicals

Though there has been no dramatic increase of trade in fine chemicals during the past year, it can be safely said that business in 1928 has shown an improvement over 1927. Accurate statistics in support of this are unfortunately not available, but there is no doubt that the Safeguarding of Industries Act of 1921 has contributed materially to the steady development of the industry with a consequent increase in trade and employment. The British Fine Chemical Industry produces some 3,000 different substances and covers the manufacture of:—

(*a*) Medicinal or therapeutical products,
(*b*) Analytical reagents,
(*c*) Photographic chemicals,
(*d*) Perfumery chemicals and essential oils,
(*e*) Solvents.

These will be dealt with seriatim.

(*a*) *Medicinal chemicals.* With medicinal chemicals the tendency has been for a better consolidation of existing manufactures. Improvements in processes have been effected which not only make competition easier, but which have substantially added to the margin of profit; these achievements are due to chemical and engineering research into the details of processes and equipment.

It is still the case that the old-established synthetic products such as phenacetin, phenazone, cbloral hydrate, amidopyrin and veronal continue to be imported. On the other hand, medicinal chemicals of more recent origin like insulin and radiostol have not only become well-established in the home market, but are in demand in many other countries.

The tendency of prices during the year has been downwards, and many instances of quite large reductions can be quoted. There have been movements upwards in the case of mercury compounds, due to the formation of a Spanish-Italian ring which has raised the price of mercury.

Among new technical developments in which progress has been made are the large scale production of pure ergosterol and of the product of its irradiation with ultra-violet light—Vitamin D—which is now being sold by itself, and in conjunction with Vitamin A, which is now manufactured in high concentration. Vitamins A and D may be added to margarine to bring its vitamin value up to that of summer butter, at a cost for the materials amounting to less than ¼d. per lb. They are proving of great value in medicine in the treatment of diseases which arise from a deficient intake of vitamins during illness or owing to other causes. In connection with this development, it must be mentioned that although the industrial production of synthetic Vitamin D was first achieved in this country, its adoption in Germany—in particular in the krankenkassen and all children's hospitals—far exceeds its use

in this country. Thus in Germany the obvious benefits resulting from Vitamin D therapy have been avidly absorbed, whereas in this country the importance of the discovery has not been fully appreciated and its adoption has been slow.

The manufacture of thyroxin by processes based on Harington's discovery has brought the cost of this medicament to a low level, and in consequence its use is being greatly extended, especially in export markets.

Another active principle, the use of which has been greatly extended during the past year, is that of ephedrine, which is derived from the Chinese drug Mah-huang. Ephedrine has proved a very valuable remedy for the treatment of hay fever, and asthma, and its manufacture on a large scale, which permits a considerable exportation, has been set up in this country.

Yet another active principle, the manufacture of which is new during the year, is the substance present in fresh liver which has been found to have specific curative properties in the treatment of that hitherto incurable disease—pernicious anæmia. In the early part of the year a process worked out in the National Institute for Medical Research was put at the disposal of manufacturers, who, by taking advantage of it, have been able to render this medicament widely available, to the great relief of those who were keeping the disease in check by consuming very large quantities of liver. The principle cannot be supplied in the pure form, but only in the form of a concentrate, the activity of which is at least forty times that of fresh liver.

Synthetic thymol and menthol continue to go ahead and great progress has recently been made with the latter in improving the standard of the synthetic compound, to a point very nearly akin to the natural product.

The exports of drugs, medicines and medicinal preparations in 1927 were valued at nearly £3,000,000, and it is estimated that there will be an increase of nearly 15 per cent. in 1928.

(*b*) *Analytical Reagents.*—Steady progress has been maintained and there is now no reason why anyone should go abroad for analytical and research chemicals, since the quality of the British products is now second to none.

(*c*) *Photographic Chemicals.*—In comparison with the two previous years, that is, 1926 and 1927, the trade in photographic chemicals was greatly benefited and stimulated by the fine summer weather of 1928, which gave the amateur photographer plenty of opportunity of indulging in this holiday amusement. The demand for that comparatively small range of chemicals required by the trade worker, who now-a-days does most of the developing and printing, has consequently been brisk and well sustained.

There have been no important changes in prices, though those of some of the developing agents have fallen slightly, with the result that they have been as low as they ever have been since the days before the war; in fact, some of them, and in particular the leading developing agent, metol, have been selling at considerably lower than the pre-war price.

There is little of importance to mention in regard to the export trade. In some markets business has been steady, while in others it has not been so good as in previous years, due to local economic and other conditions.

There have been no new developments of importance as far as the chemical side of photography is concerned.

(*d*) *Perfumery Chemicals and Essential Oils.*—Trade conditions in perfumery chemicals during the past year have shown a gradual steady improvement. This may be attributed to the expansion of business in the soap, perfumery and allied trades, a larger volume of their requirements being obtained from British manufacturers, which, it is hoped, indicates a growing appreciation of the materials which are now being prepared in this country. The prices of perfumery chemicals have remained fairly constant throughout the period, any movements being in a downward direction due mainly to competition.

Research work in connection with perfumery chemicals is proceeding steadily along very interesting lines, but there is nothing new to report this year except that isoamyl cinnamic aldehyde is now freely offered on the market. This chemical is proving of the greatest possible use to perfumers, inasmuch as it has revolutionised the preparation of Jasmin compounds.

Speaking generally, this country is holding its own as regards the production of synthetic perfumery chemicals and is gradually extending the range.

Practically all the essential oils are imported and the increase in trade in the articles into which these oils enter may be gauged from the fact that the imports of essential oils for 1928 are likely to be about 10 per cent. higher than in 1927, the value being well over £1,000,000. The business in essential oils has been of fair volume, the export trade being good, while the home trade has been quiet. The fluctuating markets and uncertainty of supplies in some directions have had their effect upon consumption. Prices have been fairly steady except in a few cases where there have been increases due to shortage of supply, *e.g.*, orange oil, oil of cloves, lemon oil, and Java citronella oil.

(*e*) *Solvents.*—We will now deal with organic solvents of a special character. At first sight these might perhaps be regarded as coming under the heavy chemical classification in that their uses are mainly developing in specialised technical trades such as lacquering, soap making, and so forth. On the other hand, certain groups of these solvents, such as the hydrogenated phenols, are themselves manufactured by very delicate synthetic processes which can fairly be included in the Fine Chemical Industry.

Considerable strides have been made in the last twelve months in applying the solvents of the latter group, such as cyclohexanol, which has for several years been on the market as a general solvent, to a number of specific uses; for example, its incorporation in dry cleaning and liquid laundry soaps, whereby the detergent effects of the older types of liquid soaps are enormously increased.

The ketones of this group, *e.g.*, cyclohexanone, and the esters of the group, *e.g.*, cyclohexanol acetate, have found a new use in lacquer and varnish manufacture, where their amazing solvent powers for copals, gums, and nitrocellulose render their prospects particularly encouraging.

Amongst plasticisers, a most useful series of compounds have been found in the derivatives of the cyclohexanol group. Considerable additions have been made to the large scale plant occupied with the preparation of these compounds, and it may fairly be said that at the present time the demands of British technical trades can reasonably be met by products of British manufacture, even allowing a large margin for a considerably increased use as their exceptional properties become more widely known and appreciated.

A somewhat similar hydrogenated benzene (cyclohexane) is now being manufactured on an intermediate scale, and holds out excellent prospects of adoption as a general solvent in Fine Chemical Industry. Ethyl lactate is another good all-round solvent which is engaging the attention of British manufacturers, and it is hoped that in this direction, too, this country will shortly be independent of the necessity of importing foreign products.

Conclusion

In this review it has only been possible to touch on a number of salient features in our chemical development, but it is hoped that enough has been said to indicate that the industry is making steady progress and is holding its own. The competition in the world markets is steadily becoming keener; but we can look forward to the future with confidence, as the industry is well organised and is being developed on sound scientific lines by men of energy and foresight.

British Preferential Tariff in Canada

THE Federation of British Industries are seriously considering the recent decision of the Canadian Government to alter the preferential basis accorded to British goods entering the Dominion. It has now been decided that as from February 1, 1929, goods claiming the British preferential rate will have to be certified as containing 50 per cent. of British raw material and/or labour, against the previous 25 per cent. The Canadian Government have stated that in making this alteration they are doing so as a benefit to British manufacturers. On behalf of manufacturers as a whole, the Federation is very sensible of this reason. Up to the present, the Dominion authorities have not issued any list of either raw materials or semi-manufactured materials which they will allow British manufacturers to count as entirely of British production in any goods they may be making. Some raw materials are unprocurable in this country; other articles reach this country after a certain amount of work has been done upon them at the source.

British Dyestuff Prices: The Users' Point of View

By H. Sutcliffe Smith

In the article published below, Mr. H. Sutcliffe Smith discusses with considerable frankness the problem of British dyestuff prices, and suggests that British makers should reduce the price factor to 75 per cent. over pre-war prices, without waiting for an agitation by the users. Mr. Sutcliffe Smith's qualifications to speak on this subject are indicated by the facts that he is executive director of the Bradford Dyers' Association, past president of the Bradford Chamber of Commerce (1919-20) *and of the Society of Dyers and Colourists* (1921-22), *chairman of the Colour Users' Association* (1921-28), *past member of the Board of Trade Advisory Committee, and a member of the Dyestuffs Advisory Licensing Committee and of the Dyestuffs Industry Development Committee.*

In your issue of December 31, 1927, you kindly gave me an opportunity of stating the users' point of view as regards the dyestuffs situation. I then drew attention to the question of the British price *vis-à-vis* the world price, the need of development in the production of new colours, the urgent necessity for the extension of export trade, the demand for cheaper intermediates, the advantages of a British Census of Dyestuffs Production, co-operation in research with the Universities, and the protection of the users' interests in any international agreements. I do not wish to elaborate these points now, except that of price. I should like to mention with satisfaction, however, that my suggestion of co-operation of industry with the Universities has been put into effect by Imperial Chemical Industries, Ltd.

The Dyestuffs Act

The Dyestuffs (Import Regulation) Act, 1920, has two years to run, and I am glad of this opportunity of paying a tribute to the advance—the amazing advance—made by the British dyeware industry during the past eight years, and I know the makers will give me credit for appreciating this to the full; but the time is rapidly approaching when the whole incidence of the Act must be comprehensively reviewed.

There is no question that the Act has assisted the industry in reaching its eminent position. There is also no question whatever that the building up of the industry during the past eight years has been accomplished through the goodwill of the users, who have acquiesced in paying prices above the world level. Whether the Act has achieved all that it set out to do remains to be seen. The acid test must come when the Act expires in January, 1931, and the consumer is no longer called upon to pay a subsidy. I think the users have a right to expect that their money has not been spent in vain, and that the industry they have helped to build will be able, without the assistance of the Act, to withstand the blast of world competition.

Many of the colour-using industries, particularly the textile trades, are now in a parlous condition and are meeting with severe competition from other textile manufacturing countries. Cheaper labour and hostile tariffs in other countries have hampered the British export trade, and in many of their former markets our exporters are having serious difficulties in maintaining their trade. These countries are competing with us in many cases with our own machinery, which they have been taught to use by British brains. It is, therefore, imperative that our goods should attain a lower level of price on a parity with our competitors, and this can only be achieved by stringent economy in production. Every item of cost will have to be scrutinised if we are not only to retain our export business but to extend it.

Lord Melchett's Views

Some time ago Lord Melchett said:—

> I can state emphatically that we do not consider the British chemical industry to be in any way inferior to the German industry. We in England can produce synthetic ammonia quite as cheaply as the Germans. Further, our costs of production of chemical products are as low as, if not lower than, in other countries.

Imperial Chemical Industries, Ltd., in one of their advertisements, state:—

> The amalgamation means economy, progress, and prosperity; effective production and equality in world competition.

Interpreted literally, what does this mean? It surely means that before long British users may expect to obtain their raw materials, chemicals, and colours at prices which will not be in excess of any of their foreign competitors. Such an assurance as this from the leader of that great industry is encouraging, and whilst it takes time for economies to be effected, I do suggest that the users are now looking forward to an early indication of these economies being translated into still lower prices.

It seems obvious to me that the British dyemakers cannot reach the same plane as the heavy chemical manufacturers unless and until they are able to secure a considerable volume of export trade, in addition to the home trade, thus enabling them to produce on a larger scale and at world prices.

I feel sure that this aspect is having the attention it deserves on the part of British makers, and I am informed that considerable progress is being made in the development of overseas business in dyestuffs.

In view of these statements by Lord Melchett, it would surely be unnecessary that his great corporation, with its large capital resources and having at its head some of the keenest cleverest brains in Great Britain, should continue to require a Prohibition Act to protect it against competition in dyewares. The Act was placed on the Statute Book for ten years *and no longer*. Now that we have got an enormously strong organisation which is capable of paying a dividend almost from its inception, an entirely different situation has been created, and there is evidently not the same urgent need for a Prohibition Act.

Suggested Voluntary Reduction of Price Factor

Notwithstanding that the importation of dyestuffs is prohibited, it is not permissible for the British makers to charge higher than twice the pre-war price for dyewares which can be purchased abroad at less than that figure. This is regulated by the Dyestuffs Advisory Licensing Committee, which will grant a licence to import colour where evidence can be furnished that the British price is in excess of twice pre-war, and the foreign price lower. An example will make this clear. If a foreign firm quotes 1s. 6d. per lb. for a dyeware that was 1s. pre-war, unless the British manufacturer will take 2s. per lb. or less, a licence is granted to import the foreign colour. Thus, an effective protection is afforded to the British makers of 100 per cent. over pre-war, or a factor or index figure of 200, whereas the Board of Trade Wholesale Prices Index figure to-day is under 140.

If the British makers studied the psychology of their customers, they would now voluntarily suggest that the factor should be, say, 175—75 per cent. over pre-war—and not wait for an agitation by the users for a lower factor.

A voluntary offer such as I suggest would bring considerable goodwill to them, and it would be tangible evidence of that progress which has been foreshadowed by Lord Melchett. It would also be an indication to the users that the extra costs of the past eight years have been justified, and in my opinion such a gesture would do much to allay the feeling freely expressed that the Prohibition Act is too onerous a handicap when the textile trades are having to battle for their foreign markets under such strenuous competition.

Nitralloy Steel

With regard to a paragraph under the above heading which appeared in this journal on December 15, we have received the following note from Nitralloy, Ltd., Norris Deakin Buildings, King Street, Sheffield: "We should like to make it clear that our company, Nitralloy, Ltd., holds the rights for the Nitration Process, and also for the special Nitralloy steels required in connection therewith, for the British Empire. John Brown and Co., Ltd., and Thos. Firth and Sons, Ltd., are our licensees for the supply of Nitralloy steels. We ourselves are prepared to grant licences for the use of our process to any users who may wish to carry out their own case-hardening by nitrogen."

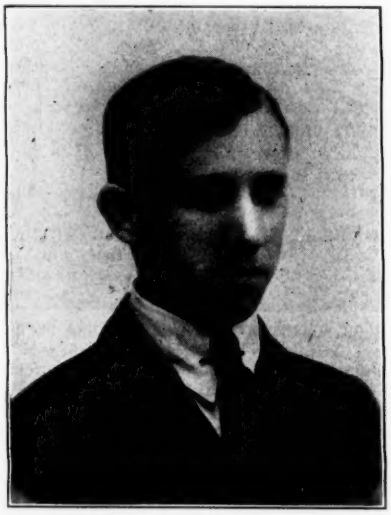
The British Dyestuff Industry: Another Year of Progress

By L. J. Hooley

The author, familiar to our readers as a regular contributor to our "Dyestuffs Monthly Supplement," and particularly well-informed on the technique and literature of dyestuff production, takes a very favourable view of the progress made during the year, and even predicts that with a few more years like 1928 the position of the British dyestuff industry would be secure for the future.

THE year, which seems to have passed so quickly, has been one of uninterrupted work for the dyestuff industry, and very substantial progress has been made in consequence. A few more years like 1928 and the position would be secure for the future. Only since 1926 has the industry as a whole been able to go forward without distraction, and the improvement in this period has been sufficient to show what can be done. There is no longer any doubt as to the industry's ability either to supply colours adequate in range and quality or to carry out research with ability and imagination.

With two of the principal firms, the British Dyestuffs Corporation and Scottish Dyes, Ltd., fused in Imperial Chemical Industries, and only limited financial information available from the others, comparison of results by individual firms is not possible.



MR. L. J. HOOLEY.

With an initial dividend distribution of 8 per cent. and an increase in the ordinary share value from about 20 to 39 shillings the prestige of Imperial Chemical Industries is on the increase. Lately the directorate has been added to by the inclusion of Lord Birkenhead, and the headquarters at Westminster are in course of complete occupation, while another huge building is announced to be built on the other side of Horseferry Road. With regard to Scottish Dyes, the new offices and laboratories at Grangemouth are nearing completion, making the latest of a long series of additions.

Scientific and technical progress is shown in the important new colours and processes brought out, the latter being more numerous than in any previous year.

Viewing developments broadly, it is hardly necessary to emphasise the significance of the search for fastness, although, to appreciate its insistence, the whole body of patent and other publications must be examined. Among the dyestuff groups, the azo and anthraquinone take the major share of the new work, and if the indigos be also included as similar to the anthraquinones, these two groups represent three-quarters of it. All the various sub-groups of the basics, triphenylmethanes, sulphur colours, nitro and other well-known classes combined, only suffice to give the remaining quarter. In some branches the British firms are only just beginning the staking of new claims, but the whole area is gradually being increasingly covered. Meanwhile, the foreign firms are taking the fullest advantage of their larger experience and accumulated resources to take possession of all the ground immediately in front.

Running rapidly over the more pronounced lines of advance at the present time and making for the moment no distinctions as to the various industries involved, these include the following :

In the azo class, attention is mainly directed to chrome colours, including soluble metallic derivatives obtained from *o*-hydroxy azo and hydroxy carboxylic acid derivatives, to new compounds of the developed class, especially to hydroxy naphthoic arylides, to fast yellows and other colours obtained from pyrazolones as components, and to level dyeing colours for artificial silk and faster direct colours for cotton. In the anthraquinones, the indanthrone, flavanthrone and dibenzanthrone classes are still being made to yield new members, while the pyrazolanthrones and newer complex nuclei are attracting more attention. Among the indigos, prominence is being given to α-naphthols as constituents, the synthesis of very highly halogenated or otherwise substituted bodies continues, and many benzene types are being extended to the corresponding naphthalene ones. In the sulphur section, products of the carbazole type fast to bleaching and products free from tendering susceptibilities are of most importance. In the basics the isoindulines, indolines, and colours for copying are to be noticed.

With regard to intermediates, the production of hydrocarbons and other derivatives by catalytic methods in the vapour phase and the synthesis of ring compounds are especially representative of present tendencies. The technique of building up polynuclear hydrocarbons has improved considerably during the last few years, and further developments are to be expected. The waxlike polychlor naphthalenes of the British Dyestuffs Corporation should also be referred to.

A few only of the important contributions of the British manufacturers can be mentioned. The British Dyestuffs Corporation are still increasing their range of Icyl colours—specially good levelling colours for regenerated cellulose silks. A wide net has been cast in the search for suitable derivatives for this series, which now includes Icyl Orange G, Icyl Orange R, Icyl Brown G, Icyl Blue G, Icyl Violet B, and Icyl Blue Black 6B.

A new addition to the range of acetyl silk colours is Celatene Navy Blue. The British Celanese, H. Dreyfus, and others have taken out interesting acetyl silk patents both for the production and use of colours. Considering the combined results of all the manufacturers, Great Britain still maintains the lead in this corner of research.

Among vat dyes there have been, to mention a few only, Caledon Green RC, a green made for the first time and without any foreign equivalent, the Caledon equivalents of Indanthrene Brown R and Brown G, Alizanthrene Blue Violet of the British Alizarine Co., and Paradone Orange R of L. B. Holliday. On the patent side the British Dyestuffs Corporation, British Alizarine Co., L. B. Holliday and Scottish Dyes have all been pursuing investigations in the indanthrone, pyranthrone, flavanthrone, dibenzanthrone and related series. L. B. Holliday have recently announced a new series of acetyl silk colours, the Solvacyls. Progress has been made with the Soledon colours and new products and processes brought out during the year. Among the azo colours, the work of J. W. Leitch and Co. may be mentioned in the application of developed colours to silk and wool. Brotherton and Co., Hickson and Partners, and Williams Brothers continue developments in their own special lines. Full details will be given in the next issue of THE CHEMICAL AGE "Dyestuffs Monthly Supplement."

Last year the increasing rate at which patent applications from abroad were being taken out was referred to in THE CHEMICAL AGE, and the increase is still maintained. A high proportion of these deal with dyestuffs, so that in spite of the rapid development of industrial chemistry in other directions there is no slackening in this section. Dissatisfaction is sometimes heard with regard to certain aspects of the British

patent system, especially as affecting chemical inventions. In this respect, the interesting report of the British Science Guild may be read. The questions involved are of unusual difficulty, but it is well, in view of the dominant importance of chemical development, that they should not be overlooked.

With the period of the Dyestuffs (Import Regulation) Act drawing to a close, the question of what is to happen afterwards is becoming of increasing importance. This has been alluded to prominently on several occasions during the year, but no authoritative proposal has been made. Whatever programme be finally decided upon, as representing the best interests of the users and makers, it must be such as will not threaten the integrity of the position achieved with so much hard work and sacrifice during the past few years.

Chemical Research under Government Direction

An Experiment that is Yielding Important Results

The establishment of a Chemical Research Laboratory at Teddington a few years ago under the general scheme of research directed by the Department of Scientific and Industrial Research, was regarded as an experiment of great interest. The following careful analysis of the work done under the directorship of Professor G. T. Morgan shows both the variety of the research work undertaken, and the important results already achieved, and justifies good hopes for the future.

In his Presidential Address to the Chemistry Section of the British Association made at Toronto in 1924, Sir Robert Robertson gave a most interesting account of the State's activity in chemistry, and in a chart illustrated the activities in various directions. As might have been expected, these were greatest in connection with the Service Departments. Unfortunately the nature of this work often precludes publication. There is, however, an increasing amount of chemical research undertaken by the Department of Scientific and Industrial Research, not with the fairly definite objectives of the work of Service Departments, but with the intention that the results shall be made generally available in the hope that they may prove of value directly or indirectly to industry.

As might be expected, the work of the Department's Fuel Research Station at East Greenwich, and the Building Research Station near Watford, includes many chemical investigations. In addition, the Department has a special Chemical Research Laboratory at Teddington under the direction of Professor G. T. Morgan. This Laboratory was set up to provide facilities of special interest to Government Departments. It is not the intention of the Department to duplicate investigations of the type normally carried out by the industry unless the direct interest of other Government Departments justifies such a procedure. Our readers may be glad of a general account of some of the more important investigations now in progress at this Laboratory.

Low Temperature Tars

The increase in the number of low temperature carbonisation plants in this country has rendered it of increased importance to know exactly what the various low temperature tars contain. This is a comparatively new raw material, and Professor Morgan has already given an outline of the solvent method of separating the major constituents at the conference of the Society of Chemical Industry held on May 14, 1928. The investigations which are proceeding in collaboration with the Fuel Research Station have been carried out on "pedigree" tars and have already reached the stage at which the commercial possibilities of some of the constituents might be investigated by industry; for example, the crystallisable phenols and the resinols which seem to be promising materials for use as lacquer intermediates.

The importance of the knowledge that is being gained about the constituents of these tars can hardly be overestimated. To carbonise coal at a low temperature is an easy problem, but to do so economically is a problem that may largely depend for its successful solution on the prices that the by-products will yield. Only the future can say whether it will pay to extract some of the interesting constituents that have been noted, for example, beta methyl anthracene and 2 : 6 dimethyl anthracene. The extraction of anthracene from high temperature tar is no longer a profitable process, as the product has been largely displaced by synthetic material. Similar work on "pedigree" high temperature tars will be undertaken as opportunity offers.

Research on Chemotherapy

The Laboratory is working in collaboration with the Medical Research Council in an endeavour to obtain experimental evidence of the relationship between chemical constitution and physiological activity. Various compounds containing acenaphthene, fluorene, naphthalene, and carbazole nuclei are being prepared, and their properties as therapeutic agents for the treatment of sleeping sickness are being tested under the arrangements made by the Medical Research Council. The Laboratory is one centre of the many involved in the general scheme drawn up by the Medical Research Council and the Department of Scientific and Industrial Research for the systematic search for therapeutic agents. Every new compound produced at the Laboratory is naturally considered from the point of view of its possible practical application, and with the facilities now afforded by co-operation with the Medical Research Council many compounds not prepared with the object of therapeutic use are in fact tested physiologically. Among such compounds may be mentioned ethylenethio-urea complex salts of gold, silver, copper, and other metals. These give stable aqueous solutions with a nearly neutral reaction and can be sterilised by heat without decomposition.

Selenium and Tellurium

The work on selenium and tellurium has been continued, and tellurium derivatives of the three cresols have been examined therapeutically. The reaction between selenium oxychloride and phenols has been re-examined in view of inaccuracies in the literature on the subject, and selenonium bases of a new type have been discovered.

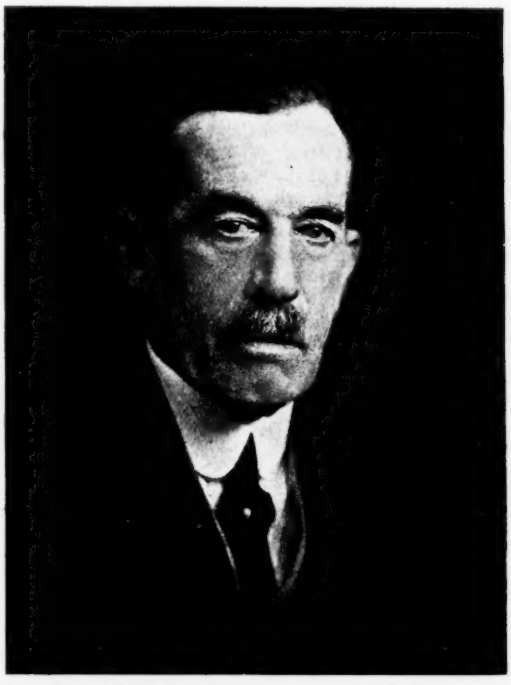
Corrosion

The experimental work for the Corrosion of Metals Research Committee that was formerly carried out at the Royal School of Mines is now carried out at the Chemical Research Laboratory. At the moment, the work is largely devoted to the study of the factors that control the rate of corrosion of zinc in solutions of potassium chloride. For the first time a complete set of corrections has been obtained that show the variations in time of the rates of total corrosion, corrosion due to the evolution of gaseous hydrogen, and corrosion due to the absorption of oxygen. The curves for the latter, for the first part of their courses, are either exponential (in dilute solutions) or straight lines (in strong solutions). The exponential form is obtained when the concentration of chlorine ions is the controlling factor, the straight line form when the rate of oxygen supply controls corrosion. Accumulations of secondary corrosion products only affect the form of the curves after unexpectedly long periods.

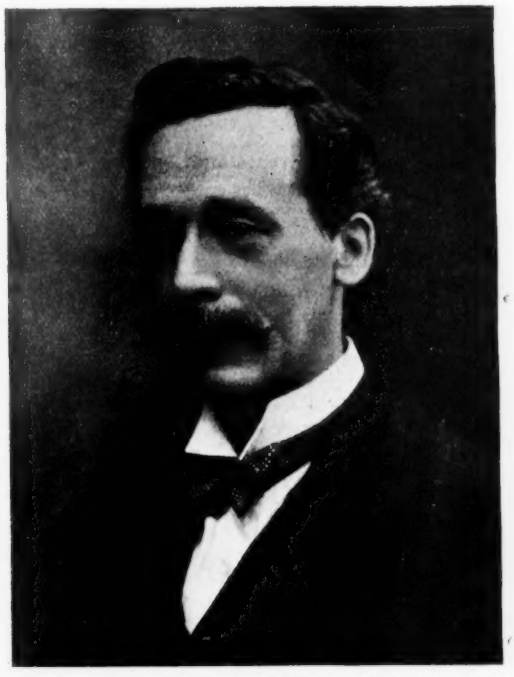
The work on atmospheric corrosion has included the investigation of the properties of oxide films produced on zinc by exposure to air at various temperatures between 150° and 390°. The properties of the films so produced were investigated by determining the weight-increments on subsequent exposure to the atmosphere. Work on the analysis of corrosion products has necessitated the investigation of methods of estimating small quantities of carbonate in the presence of sulphide and chloride. Attempts have been made to improve and preserve the appearance of copper specimens exposed to the air, and progress has been made in planning laboratory investigations with synthetic atmospheres.

High Pressure Gas Reactions

An experimental plant has been designed for the general investigation of high pressure gas reactions. Our readers will be fully aware of the steadily increasing importance of high pressure reactions. From a purely scientific point of view, the study of such reactions is inhibited by the cost of

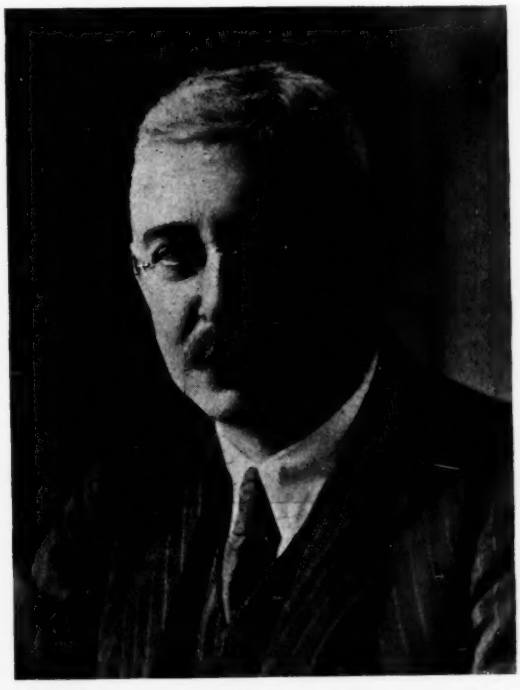


Sir D. Milne-Watson, Governor of the Gas Light and Coke Co.



Professor G. T. Morgan, Director of the Chemical Research Laboratory, Teddington.

Dr. J. Vargas Eyre, Director of Research to the Distillers' Co.



Dr. J. P. Longstaff, retiring Secretary of the Society of Chemical Industry.

the necessary apparatus, and the necessity of the continuous employment of highly skilled staff. In consequence, little research of this nature is in progress at universities—perhaps the best equipped chemical laboratory in a university institute is that of Professor Bone at the Imperial College of Science and Technology. In addition to the general scientific importance of the subject, it has a special importance from a national point of view in that it opens up a new field for the possible synthesis from indigenous materials of many important chemical substances which now have to be imported.

Synthetic Solvents and Resins

The work of the Laboratory has hitherto been devoted to a study of the synthesis of solvents from carbon monoxide and hydrogen. In the course of this work, much of which has been on well-known lines, considerable experience has been acquired. Some quite new facts have emerged. A special catalyst has been found that alters the course of the reaction in the methyl alcohol synthesis, with the result that a considerable amount of ethyl alcohol is formed. In addition, a detailed study of the reaction products has suggested the reactions by which the carbon linking arises. It is to be hoped that the continuance of these researches will help to define the word "catalyst," which in a recent patent case was rather contemptuously referred to as a label to indicate what a substance does, and not what it is.

The Department started its investigations on synthetic resins chiefly in view of their use as insulators. The Service Departments and electrical manufacturers complained that the commercial products varied from batch to batch and that it seemed to be impossible to obtain standard repeatable products. This lack of uniformity is especially objectionable in the electrical industry. The researches at the Chemical Research Laboratory are of a fundamental character with the object of gaining that exact knowledge of the intermediate and final stages which will enable standard resins to be prepared having the particular characteristics requisite for the particular object in view. Both acid and alkaline condensations are being studied in the case of phenol-formaldehyde mixtures. Fusible resins have been prepared from meta- and para-cresols having high insulating values and melting points over 100°. An almost colourless resin has been produced from meta-cresol. Interesting resins have also been obtained by condensing formaldehyde with acenaphthene and fluorene and their derivatives. These are soluble in organic media, and have insulating properties.

Technical Progress of the Nitrogen Industry in 1928

By E. B. Maxted, D.Sc., Ph.D.

For the tenth year in succession Dr. Maxted reviews, in his customary thorough way, the general trend and main technical developments in the nitrogen industry. It is interesting, among other things, to note his conclusion that the technique of large scale working with compressed gases is now, if anything, less dangerous than the average ordinary chemical process.

An outstanding feature of the present position of the nitrogen industry is the continuation of the increase both in the world consumption of fixed nitrogen and in the extensions to nitrogen fixation plants which are being made in all parts of the world in order to meet this increased demand. The increase in the annual consumption is now well over 100,000 tons of fixed

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nitrogen; moreover, this figure, in spite of its dimensions, is growing from year to year. The saturation point of the world market with regard to nitrogen products is necessarily difficult to judge; but it is significant that almost all the firms to whom the proper appraisement of the future selling prospects of even greater quantities of fixed nitrogen is of the greatest interest—for instance, the I.G. Farbenindustrie in Germany and Synthetic Ammonia and Nitrates, Ltd. in Great Britain—are undertaking important extensions; further, that these extensions concern, as in former years, the production of ammonia by direct synthesis.

A radical change in the general policy of ammonia manufacture, which is gradually creeping into the industry, involves a complete revolution in the method of hydrogen production. Save where cheap electrical energy permits the manufacture of electrolytic hydrogen, this gas is being derived in increasing quantities by the low-temperature treatment of coke-oven gas and, in the works of the I.G. Farbenindustrie, by the gasification of lignite.

Considerable attention has been given during the year to the production of ammonium salts containing phosphorus, both alone and in conjunction with potash; for instance, the output of nitrophoska by the I.G. is stated now to be of the order of 320,000 tons per annum. The problem of extraneous acid for ammonia fixation is being solved partly by the manufacture, on a very large scale indeed, of mixed salts containing nitrate, such as Leunasalpeter—an equimolecular mixture of ammonium sulphate and nitrate—and nitro-chalk, which is a mixture of ammonium nitrate and calcium carbonate, recently placed on the market by Synthetic Ammonia and Nitrates, Ltd. If it be considered that the cost of sulphuric acid, for fixation of ammonia as sulphate, is nearly equal to that of the ammonia itself, the urgency of avoiding this introduction of an agriculturally relatively useless constituent into commercial fertilisers is at once seen, even if the problem be mitigated to some degree by the utilisation of gypsum in place of acid. Ammonium nitrate, if only from its explosive nature, is not suitable for large-scale manufacture; and the future trend of the industry would seem to lie towards a series of products containing both ammonia and nitrate nitrogen, in addition, in some cases, to bodies such as lime, potash and phosphorus.

In this connection, much pioneering and educational work is being done by propaganda both in this country and in Germany; and the recession of the apparent maximum sales limit of nitrogenous fertilisers is undoubtedly to a large degree due, firstly, to the cheaper prices of nitrogen, and, secondly, to the increasing realisation on the part of farmers of the possibilities which are coupled with more intensive manuring.

In the Chile nitrate industry, the resumption of free selling, together with the possibility of fluctuations in price to suit the local conditions of the consumer, has led to somewhat greater activity; but, in spite of improved methods of extraction and of a government subsidy, the production of Chile nitrate has ceased to be the predominant factor in determining the world output of fixed nitrogen.

Finally, mention may be made of the second International Nitrogen Conference on board the S.S. *Lützow* in May last.

The resolution passed at the end of the conference is worthy of being cited, since it summarises in itself the vastness of the part played by the nitrogen industry in modern economic life. Part of the resolution runs as follows: "Those present at the second International Nitrogen Conference are agreed that food, clothing and other requisites of a growing population can only be provided in sufficient quantity and without risk of a rise in prices if artificial fertilisers are used on an increasingly liberal scale. The growing use of artificial fertilisers, therefore, constitutes one of the most important means of promoting the well-being of humanity."

Of the patent specifications and published work of the year, the following may be noted specially:

Synthesis of Ammonia

The increasing importance of liquefaction processes for the preparation of the constituent gases, for instance by the low-temperature treatment of coke-oven and other fuel gases, has already been mentioned, a special advantage of this method being that poisons, such as hydrogen sulphide and carbon disulphide, are removed, not only by virtue of the low temperature, but also by the washing action of the liquefied gases on the hydrogen produced. As a variation of this method of purification by washing out the poisons in non-aqueous solvents, L'Azote Inc. (Brit. Pat. 258,887) describe the partial conversion of the hydrogen and carbon monoxide, contained in the original fuel gas, into methyl alcohol, by passage over a catalyst containing zinc carbonate or a mixture of zinc and chromium hydroxides, this methyl alcohol being used as a solvent for washing the hydrogen under pressure. A further method of low-temperature treatment of fuel gas for the preparation of hydrogen and nitrogen is contained in Brit. Pat. 292,342 (1), for details of which the abstract mentioned below should be consulted.

With regard to catalysts, the I.G. (2) has protected the use for the synthesis of ammonia of iron produced by the thermal decomposition of iron carbonyl, particularly in the presence of small quantities of activators, such as oxides of aluminium or magnesium. A. Mittasch and E. Kuss (3) have published an interesting investigation on the question of the decomposition of complex iron-nitrogen compounds employed as catalysts. They come to the conclusion that catalysts such as iron-aluminium-ferrocyanide decompose in use into free iron, iron carbide, nitride, etc., and that the actual catalyst is free iron. Proof of the nature of the actual catalyst in such cases is extremely difficult, especially since many molecular species are undoubtedly present; and the matter is to some degree reminiscent of the controversy which arose some years ago in connection with hydrogenation catalysts, namely as to whether nickel itself or an oxide of the metal was the active constituent.

Whereas the formation of ammonia was, in the first stages of the synthesis, regarded as a difficult reaction, the present trend in furnace design is towards methods for equalising the temperature throughout the catalyst mass, by the introduction of means for the absorption of the heat of formation of ammonia. Two types of furnace, containing a catalyst mass, the temperature of which is controlled by gas tubes embedded in it, have been described (4) and attention may also be drawn to a specification of I. W. Cederberg (5) in which the catalyst container is provided with lateral passages for the gases, with the object of equalising the temperature. A description of other ammonia furnaces, proposed by the Société L'Air Liquide, has been published in Brit. Pats. 288,577, 289,759 and 289,823 (6).

For the removal of ammonia by liquefaction, F. Uhde (Brit. Pat. 272,929) passes the circuit gases in indirect contact with liquid ammonia which is evaporated in a vacuum. The low temperature obtained removes the ammonia practically completely. This policy, which enables the ammonia catalyst always to work on the most advantageous portion of the ammonia formation curve, differs from certain existing systems, in which a considerable percentage of ammonia is allowed to re-circulate to the synthesising chamber. A further process of removal of ammonia from the circuit gases, in which this is effected in two stages, has been proposed by the Nitrogen Engineering Corporation (7).

With reference to the conditions of labour in ammonia works, it is interesting to note (8) that the rate of accidents in the Leuna factory, at Merseburg, is below the average for the German chemical industry generally; moreover, no case of poisoning from nitrous fumes has occurred. The technique of large scale working with highly compressed gases has undoubtedly now arrived at a stage at which this is, if anything, less dangerous than the average ordinary chemical process.

Ammonium Salts

The preparation of neutral sulphate has now become more or less standardised (although different methods are used in various works) and little fresh matter on this point has been published during the year. On the cause of caking of sulphate, a paper by W. G. Adam (9) is worthy of note. Caking takes place by the loss of moisture of the surface layers and by the formation of small crystals by reason of this evaporation. The direct formation of sulphate by the interaction of gases from a contact sulphuric acid plant, ammonia and water, whereby the salt is obtained in a dry condition without the necessity for evaporation, is discussed by S. Robson (10). The ammonium sulphate is separated in settling chambers and finally in filter bags. Ammonium chloride is not manufactured on the same large scale as the sulphate; two patents dealing with this may, however, be mentioned. In the first place, Moore, Polack and the Castner-Kellner Alkali Co. (11) describe a variation of the process cited in last year's report (12) in that the tough fibrous crystals required are made by allowing gaseous hydrochloric acid and synthetic ammonia, saturated with moisture at atmospheric pressure, to react at 230–240° C., this high temperature preventing condensation of water with the ammonium chloride. In the second place, H. Howard (13) claims a process in which hydrochloric acid and ammonia are added continuously to a saturated ammonium chloride solution, the heat of reaction being used to concentrate the liquid. Finally, details of the production of ammonium chloride by the interaction of ammonium sulphate and sodium chloride in solution have been published by E. Hochberger (14). By cooling under conditions described in the paper, sodium sulphate and ammonium chloride can be crystallised out separately, and the mother liquor is used again for the first stage of the cycle.

Ammonium phosphate is of special importance on account of the fertilising value of the phosphorus portion of the salt, and several specifications dealing with the manufacture of this have appeared during the year. Thus, the Chemical Foods Co. (15) treat phosphatic rock with ammonium bisulphate solution. The calcium sulphate formed is removed, and ammonia is added to give triammonium phosphate, which is crystallised out. On heating this, a mixture of mono- and diammonium phosphate is obtained and ammonia liberated. A further method of preparation—by the interaction of tricalcium phosphate, phosphoric acid and ammonium sulphate under pressure—has been described in detail by C. Mückenberger (16). By this method, the tricalcium phosphate is converted into a soluble form of phosphorus; and, as in the process described immediately above, the calcium sulphate may be used in the usual way for the production of fresh ammonium sulphate. The main reaction would seem to be worth consideration from a technical standpoint; and, in this connection, Brit. Pats. 293,942 and 290,518 (17) may also be studied.

Nitric Acid and Nitrates

The success of the direct synthesis of ammonia has, from the first, depended to a large degree on the low energy require-

(1) THE CHEMICAL AGE, Vol. XIV, p. 84.
(2) Brit. Pat. 267,554.
(3) *Zeitschr. f. Elektrochem.* 1928, **34**, 159.
(4) F. Uhde, Brit. Pat. 259,230 and G. Claude, Brit. Pat. 282,658, THE CHEMICAL AGE, Vol. XVIII, p. 204.
(5) U.S. Pat. 1,673,966.
(6) THE CHEMICAL AGE, Vol. XVIII, p. 555 and Vol. XIX, p. 11.
(7) Brit. Pat. No. 287,072; THE CHEMICAL AGE, Vol. XVIII, p. 495.
(8) THE CHEMICAL AGE, Vol. XVIII, p. 71.
(9) THE CHEMICAL AGE, Vol. XVIII, p. 4.
(10) Brit. Pat. 289,950; THE CHEMICAL AGE, Vol. XVIII, p. 535.
(11) Brit. Pat. 290,045.
(12) Brit. Pats. 273,093 and 274,263; THE CHEMICAL AGE, Vol. XVII, pp. 133 and 199.
(13) U.S. Pat. 1,654,125.
(14) *Chem. Zeitung*, 1928, **52**, 22.
(15) Brit. Pat. 297,009, ex *Brit. Chem. Abstr.*, B, 1928, p. 815.
(16) *Zeitschr. f. anorg. Chem.*, 1928, **169**, 81.
(17) THE CHEMICAL AGE, Vol. XVIII, p. 579.

ments per kilo of nitrogen fixed ; but it is interesting to have some recent figures on the comparative power for the arc process and for the direct synthesis. E. Briner (18) states that, in modern practice, each kilowatt year of electrical energy will, by the arc process, fix 120–140 kilograms of nitrogen, whereas, by the Haber-Bosch process some 600 kilograms of nitrogen per kilowatt year are fixed, assuming the hydrogen to be generated electrolytically.

W. R. Ormandy has described a noteworthy and unusual case of catalysis of a flame reaction (19). If a fuel gas be allowed to burn under water at a pressure, for instance, of 90 lb. per square inch, little or no nitric acid is formed ; however, if a small proportion of a vanadium compound(the patent cites 0.04 per cent.) be added to the water, a considerable proportion of nitric acid is produced. This reaction is certainly worth further investigation both on account of its techical bearing and by reason of its being an unexpected example of catalysis at flame temperatures.

Little fresh work has been done on ammonia oxidation. Fauser (20) claims considerable advantages in using pressure for this reaction, especially by reason of the smaller plant required for the absorption of the nitrogen oxides, due to the increase in the rate of oxidation of these to nitric acid at an increased pressure. A variation in the method of absorption of nitrogen oxides—by carrying this out in stages, with nitric acid of increasing concentration, preferably at a low temperature—is described by the Elektrizitätswerke Lonza (21), the advantage of the method of working being that the nitrogen peroxide formed in the earlier stages is absorbed by the more concentrated nitric acid. A patent of the I.G. for the drying of gases containing nitrogen oxides may also be mentioned. Sulphuric acid of 60–65 per cent. strength is used, since this does not absorb appreciable quantities of oxides of nitrogen under the conditions employed.

Passing to a short consideration of publications dealing with sodium nitrate, attention may be directed to a paper by M. A. Hamid (22) in which the various salt systems involved in the leaching of caliche are discussed, with particular reference to the Guggenheim and similar processes. An interesting patent (23) which has appeared during the year, describes the preparation of sodium nitrate from caliche liquors by adding sodium sulphate to form the double salt, $NaNO_3$. $Na_2SO_4.H_2O$, which is only slightly soluble. This is separated as such, heated to a temperature above 70° C., whereby the double salt is decomposed, and treated with just sufficient water to dissolve out the sodium nitrate.

Work has been done on the formation of sodium nitrate by the action of oxides of nitrogen on solutions of common salt. In a patent of the I.G. (24) the non-absorbed portion of the nitrogen oxides, which is obtained mixed with the hydrochloric acid formed, is recovered by scrubbing with sulphuric acid under pressure. The oxides of nitrogen are absorbed as nitroxylsulphuric acid, while the hydrochloric acid passes through relatively unabsorbed. The use of pressure in the process is also described in Brit. Pat. 283,772, according to which a solution of sodium chloride is treated with oxides of nitrogen at 6 atmospheres and at 35° C. On cooling to 15° C., sodium nitrate separates out. Finally, mention may be made of the preparation of ammonium nitrate, free from nitrite, by the passage of oxides of nitrogen and ammonia into a saturated ammonium nitrate solution, to which have been added small quantities of manganese compounds as a catalyst (25).

Other Nitrogen Compounds

Less work than usual has been done on other forms of combined nitrogen ; indeed, ammonia and the nitrates in themselves now cover the greater part of the nitrogen industry, as far as heavy chemicals are concerned. Attention has, however, been paid to improvements in the manufacture of hydrocyanic acid. Thus, the I.G. (26) claim the production of this body by passing formamide or ammonium formate, together with ammonia or inert gases, over metallic catalysts at temperatures above 300° C. at a high velocity and under reduced pressure, while Synthetic Ammonia and Nitrates, Ltd. and T. Ewen (27) employ, in a somewhat similar process, refractory oxide catalysts supported on metallic gauze. A. R. Frank and N. Caro (27a) describe a process in which a mixture of ammonia and carbon monoxide is passed over oxides of the alkaline earths at a temperature of 700–800° C. (28), and P. F. Magill and P. J. Carlisle recommend the passage of formamide vapours through heated brass tubes at 450–600° C. (28a).

Finally, some attention continues to be paid to the preparation of cyanamide from calcium cyanamide. A. N. Ericksen (29) claims a process in which calcium cyanamide is treated with water and carbon dioxide at 10–20° C. The sludge precipitated is treated with carbon dioxide at 32° C., a solution of cyanamide, together with calcium carbonate, being obtained.

If the present position of the nitrogen industry be considered analytically, synthetic ammonia will still be seen to occupy a position of outstanding interest. Two sharply differentiated policies have now sprung from the original Haber-Bosch process, one of which, namely, that represented by the Claude and, to a lesser degree, by the Casale system, aims at operation at a relatively high pressure, while the newest important entrant into the ammonia field, namely, the Mont-Cenis system, operates at relatively low temperatures and pressures, an intermediate position between these two methods of working being occupied by the Haber-Bosch process itself and by the synthesis as operated by Synthetic Ammonia and Nitrates, Ltd., at Billingham.

(18) *Bull. Soc. Chim. Belg.*, 1928, **37**, 169.
(19) Brit. Pat. 296,121 ; THE CHEMICAL AGE, Vol. XIX, p. 322.
(20) Second International Nitrogen Conference, May 1928 ; see also *Giorn. Chim. Ind. Appl.*, 1928, **47**, 601.
(21) Brit. Pat. 289,412 ; THE CHEMICAL AGE, Vol. XVIII, p. 615.
(22) *J. Indian Chem. Soc.*, 1927, **4**, 515.
(23) Brit. Pat. 290, 860 ; THE CHEMICAL AGE, Vol. XVIII, p. 580.
(24) Brit. Pat. 283,771 ; THE CHEMICAL AGE, Vol. XVIII, p. 149.
(25) Elektrizitätswerke Lonza and E. Lüscher, Swiss Pat. 118,962.
(26) Brit. Pat. 269, 166.
(27) Brit. Pat. 292,749 ; THE CHEMICAL AGE, Vol. XIX, p. 85.
(27a) Brit Pat. 282,379.
(28) THE CHEMICAL AGE, Vol. XVIII, p. 183.
(28a) U.S. Pat., 1, 675, 366.
(29) U.S. Pat. 1,671,183.

Marble Art Forgeries

Chemical Tests Suggested

IN the course of a letter to *The Times*, Professor A. P. Laurie suggests a method of determining whether marble sculptures are genuine or forgeries. " I write to suggest," he says, " that in the case of modern forgeries pretending to be old works of art executed in marble, a chemical examination would probably prove useful in detecting the fraud. A short time ago I had the opportunity of analysing samples taken from a drill put into the interior limestone of Lincoln Cathedral. The analysis of these samples, taken at different depths, proved of considerable interest. In the first place, they showed the extent to which the sulphur gases in the air had converted the carbonate of lime into sulphate of lime, the percentages being 4·3 at one-quarter of an inch depth, 4 at one-half inch, 3·7 at three-quarters of an inch, and 2·4 at one inch. An analysis of the limestone fresh from the quarry, which was still being worked, out of which the Cathedral has been built, showed that it was practically free from sulphate of lime. We get here, then, a change which must have taken a long time on the surface of the limestone which has been exposed to atmospheric conditions.

" It might be argued, however, that the extent of this change depended not so much on time as on the amount of sulphur acids present in the air owing to the burning of coal ; but another change had also taken place due to the universally distributed carbonic acid gas, this being found in excess of the amount required to form carbonate of lime in the outer layers of the stone, being present in excess in the first quarter of an inch to an amount of 4·2 per cent., at the depth of half an inch 4 per cent., and one inch 1·1 per cent. It is evident, then, that the limestone has been slowly absorbing and combining with carbonic acid gas, which must be entering from the surface. It is therefore probable that, if drills were made into marble monuments of known age and the excess of carbonic acid gas present in combination at different depths were made, an approximate indication would be obtained as to how long the changes took, and it should be quite easy to recognise a modern forgery by the absence not only of sulphate, but also of an excess of carbonic acid gas. There should be no difficulty in finding a place to make the drills which would in no way injure the statue."

Conditions in the Heavy Chemical Industry in 1928

By P. Parrish, A.I.C., M.I.Chem.E.

Among the interesting topics dealt with in the following article are the relative merits of the various methods of production of ammonia compounds (special attention being paid to various aspects of the by-product ammonia industry); the production of sulphuric acid; and the superphosphate industry.

In concluding last year's review it was suggested that 1928 could be approached with confidence and hope. Certainly, the Board of Trade returns for the first eight months of the year under review were distinctly encouraging, and revealed that many of the markets lost as a result of the 1926 strike have been regained, and that additional ground has been recovered. The September returns were not so satisfactory, although there were no striking instances of decline. What was evident was that there had been a slight general falling off. The figures for October and November are reassuring, and it is now certain that 1928 signalises a definite advance.

The heavy chemical industry affords some difficult problems to the statistician. No one who has studied the census of chemical production in 1924 and has made a contrast with 1907 can reach any other conclusion. Any such comparisons are far from impressive evidence of the growth of the chemical

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industry during the century. It is not improbable that since 1924 the rate of increase, at any rate in normal years, has been greater than previously.

Scientific Utilisation of Coal

The scientific utilisation of coal and its connection with the heavy chemical industry appears to be more firmly established than ever. It is not unlikely that synthetic ammonia factories will seriously consider the development of the Bergius, or other such hydrogenation process. As was pointed out last year, the same class of technique is involved as forms the basis of synthetic ammonia manufacture.

The cost of hydrogen prepared from coke oven gas and compressed at 200 atmospheres is said to be approximately 21.5d. per thousand cubic feet.

Reading between the lines of a discussion by Dr. Lander, as reported in the *Journal of the Institute of Fuel* for April, 1928, it would appear that there is no immediate prospect of producing oils from British coals at a less cost than 1s. 3d. per gallon. If this is the case, then the liquefaction of coal can only assume importance as a war-time measure. Whether this is an example, not unusual in recent times, of the establishment of successful technique accompanied by economic uncertainty, time alone will show. That the production of cheap hydrogen still remains an unsolved and pressing problem is undoubted.

Synthetic Ammonia

No technical developments of outstanding importance can be recorded, but interesting information has been published concerning the synthesis of ammonia, which admits of deductions being drawn as to the relative economic merits of the various processes. In general, all the last-named are based on the work of Haber and his colleagues. The pressure at which the synthesis is effected is the distinguishing feature. In this connection the following details are of interest.

Process.	Synthesis Pressure Atmospheres.
Mont Cenis (Germany) } Atmospheric Nitrogen Corporation }	100
I.G. Farbenindustrie A.G. } Billingham }	200
Fauser (Italy)	300
Casale	500–700
Claude	900

The Claude and Casale processes, operating at 500 to 900 atmospheres, have the advantage that the power required for the gas circulation is considerably reduced. The evolution of quantities of heat at the higher rates of conversion possible at these pressures renders treatment impossible in the small space available.

The forgings manufactured must be very small, and large in number, or the conversion must be retarded as in the Casale process, by leaving ammonia in the circulating gas. Multiplication of apparatus with corresponding increase in the number of operatives must inevitably result from either alternative.

The most economical working pressure, alike from the viewpoints of engineering construction and operation, would appear to be 200 to 300 atmospheres. It is stated that the cost of production of ammonia by such a process is lower than by any other, attributable (*a*) to the adoption of large units of plant, and (*b*) to the use of direct steam instead of a small number of electrical drives.

Power in Ammonia Synthesis

On the subject of power, Sir Alexander Gibb has pointed out that the direct synthetic process requires about one-sixteenth of the power used in the arc process. For this reason, and owing to the fact that use can be made of exhaust steam, the synthetic process is entirely independent of water power.

The view was expressed with confidence that a modern 100,000 kw. steam power station, in the most favourable circumstances, could be built to produce electricity on the basis of a 100 per cent. load factor at 0.185d. per unit at the switchboard. This statement should be read in conjunction with that made by Lord Melchett to the Institute of Fuel, to the effect that a boiler plant under erection at Billingham would generate steam at a higher pressure than in any other country, and produce electricity at 0.165d. per unit.

Synthetic Ammonia Costs

The question may well be asked: "What is the cost of producing synthetic ammonia and of converting it into ammonium sulphate by the anhydrite process?" Various figures have been given. Some say that synthetic ammonia, with a large plant, can be produced at £12 per ton; others suggest £15, and others affirm that £17 10s. per ton is a probable figure. For smaller plants the figures are obviously much higher. The conversion costs of producing ammonium sulphate from synthetic ammonia by the anhydrite process are variously estimated at from £2 to £2 10s. per ton, including all legitimate items of expenditure.

Whatever may be the precise costs, an indication has been forthcoming during the year that the limit of low prices of synthetic nitrogenous fertilisers has been reached. The report that the German Nitrogen Syndicate had increased the price of its synthetic ammonium sulphate by one shilling

per 1,000 kilos because of the small increase in railway rates, certainly aroused interest. Whether the speculation in question will be borne out by events time alone will show.

Fixation of Nitrogen by Micro-organisms

Are synthetic ammonia factories likely to be superseded? It has been known for some time that micro-organisms are capable of fixing nitrogen. How this is effected, and what conditions promote such fixation, are now the subject of earnest experiment. There are apparently two groups responsible for the bacterial fixation of nitrogen—azobacteria and legume bacteria. These groups are each being actively studied.

However remote the utilisation of the above possibility may be, it is one that cannot altogether be disregarded. Dr. R. E. Slade, of Synthetic Ammonia and Nitrates, Ltd., has pointed out that there are two ways of considering the problem. Firstly, the production in huge fermentation tanks of a nitrogen product supplying the organism with its food; and secondly, a further development of the process of fixing nitrogen *in situ* in the fields—a process occurring to a considerable extent to-day—one which is employed in the ordinary five-year cycle of crops.

Although improvements may conceivably be made in the fixing of nitrogen *in situ*, such processes are seemingly not rapid enough for intensive cultivation. Fermentation processes are notoriously slow, and vats extraordinarily large and numerous would be demanded.

By-Product Ammonia

As was remarked last year, no chemical industry is faced with bigger problems than the by-product ammonia industry. No emphasis is needed to reveal the urgency of the matter from the commercial point of view. The balance sheets of many gasworks have been published, disclosing a loss in the manufacture of sulphate of ammonia under present conditions.

Not only will it be necessary for central works to be established, but these must be conducted on co-operative lines. Those responsible for their establishment must have available not only cheap raw materials for ensuring the fixation of by-product ammonia, but they must be alive to the possibility of new outlets of disposal. These should not necessarily involve a fixation medium. A wider view and greater vision are needed in this matter.

The formation of committees to examine important phases of the by-product ammonia problem is certainly a salutary step, but apart from examining certain specific processes for the recovery of by-product ammonia in various forms, it is no less vital to study new outlets for, and possible fresh applications of, ammonia or ammonium compounds.

Attention was directed to certain technical and economic aspects of the problem in question at the recent Fuel Conference of the World Power Conference in September. Intimate contact with the problem and practical knowledge of its various ramifications led to the submission of certain suggestions which called for close examination. Criticism was levelled against some of the statements on certain grounds. In no single particular is it necessary to retract what was said.

Direct and Semi-Direct Processes

Corrosion of mains by hydrochloric acid is known. The quality of the tar is certainly affected, and the devil water—the aqueous condensate after the saturators—is not less noxious than the effluent liquors arising in the distillation of gas liquor, and no less difficult to deal with. But it is inexpedient, on more pressing grounds than the foregoing, to recommend the installation of the direct or semi-direct processes at gasworks.

Fortunately, by-product and synthetic ammonia are being marketed largely by a common selling organisation. Whether this happy state of things will always continue remains to be seen. Certain it is that if a breach occurred, quality of product would be an important, nay, indeed a deciding, factor.

The sulphate of ammonia made by the direct and semi-direct processes is not so satisfactory as the synthetic product. There is no reason why sulphate of ammonia made by the indirect process, or by a process involving evaporation under vacuum of a solution of ammonium sulphate, should not be equal to, if not better than, the synthetic product.

An American View

Mr. C. J. Ramsburg, of the Koppers Co., Pittsburgh, dealt with the subject of by-product ammonia as affecting the United States at this year's convention of the National Fertiliser Association of the United States. He emphasised that the increase in agriculture and in industry is such that no longer could by-product ammonia be depended upon to maintain the proportion of the market which it had been holding in the past ten years. In 1926, 633,649 tons of ammonium sulphate were produced in the United States from coke ovens. By the end of 1928, it was estimated that the quantity would increase to 822,339 tons. He declared that the synthetic production of ammonia in the United States and the world would increase to meet the inevitable increase in the demand for nitrogen, which would occur at a rate beyond the power of the by-product coking industry to satisfy. By-product ammonia, he affirmed, would continue to be produced in slowly increasing quantities.

As regards by-product ammonia, space does not admit of more than brief mention of Mr. W. G. Adam's contribution on the "Caking of Sulphate of Ammonia," of certain designs of saturators which have been patented for the manufacture of crystalline salts, of the production of sulphate of ammonia by bringing crude coal gas into contact with anhydrite, or of the production of mixed phosphatic fertilisers by the action of ammonia in crude coal gas on calcium superphosphate. It should be remarked that one of the disadvantages of the latter process is due to the reversion of some of the water-soluble phosphate to the citrate-soluble form.

Dr. Parker's paper on "Gasworks Effluents" merits careful consideration, but it is believed that the problem still remains to be attacked from another angle.

Sulphuric Acid

The sulphuric acid industry would be affected adversely if new methods were developed for the fixation of by-product ammonia. Existing processes are frequently being reviewed in the light of the admonition that sulphuric acid should be avoided by transforming ammonia into urea or by saturating it with phosphoric acid.

Fortunately, the pyrolytic process for the production of sulphuric acid has not made much advance, and its adoption in this country seems unlikely at the moment. The Dorr-Liljenroth process is receiving deserved attention. It takes several forms. The principal one is cyclic in character, involving the manufacture of diammonium phosphate and calcium nitrate from (*a*) ammonia (by-product or synthetic), (*b*) ground phosphate rock treated with sulphuric acid in the manufacture of phosphoric acid, and (*c*) the utilisation of precipitated calcium sulphate in the production of ammonium sulphate. Incidentally, the calcium carbonate produced from the latter process can be treated with nitric acid obtained by the oxidation of ammonia (Ostwald process) to yield calcium nitrate and release carbon dioxide for the carbonatation process. By this method the use of sulphuric acid is reduced by about 50 per cent., and evaporation costs are minimised, because ammonium sulphate solution is used instead of wash water to arrest the phosphoric acid remaining in the calcium sulphate residue.

Pyrites and Brimstone

Whether, during the next year or eighteen months, supplies of Sicilian brimstone will be maintained as satisfactorily as in the past few years seems doubtful. Political movements in Italy and the possible advance in the price of brimstone may induce some manufacturers to resort to pyrites in lieu of brimstone.

The sale of Rio Tinto pyrites has increased, not only in this country, but in America, where an ore containing about 50 per cent. of sulphur and about 0·5 per cent. of copper is being used. The resulting cinders are washed with weak sulphuric acid and water for the recovery of copper, and the purple ore is finally sintered in Dwight-Lloyd machines. The Rio Tinto ore has given satisfaction in the United States, and the arrangement for purchasing outright represents one that might with advantage be adopted in this country, particularly by large works which require sulphuric acid largely for the manufacture of calcium superphosphate.

The Liquid Phase Process

It is known that in the matter of technique the liquid phase process is rapidly gaining ground. More than eighty additional

Gaillard turbo-dispersers have been installed during the last twelve months. Several of our enterprising colonies are profiting by this new method. It is one that merits careful consideration, as it represents a distinct advance on former practice.

Two features are of interest as regards the contact process. Both relate to new catalysts. The vanadium catalyst, as introduced on the market by the Monsanto Chemical Works of St. Louis, has been in use for some time, and is said to be unaffected by the usual catalyst poisons, such as arsenic, chlorine, etc. Its behaviour with respect to temperature, conversion, equilibrium and activity closely parallels that of the best platinum catalyst.

The use of silica gel as a carrier for platinum has aroused considerable interest. In the contact process at the Davison Chemical Co.'s plant at Baltimore, the cost of platinum required in the catalyst is said to have been $20,000, as contrasted with a cost of $100,000 if the platinum needed had been used in conjunction with any other base material.

The Superphosphate Industry

Not only is an increasing business being done by some of our largest manufacturers, but the announcement that several thousand tons of calcium superphosphate have been exported constitutes a happy augury.

Much comment has been made about the amalgamation of I.C.I. with a certain group of fertiliser works in Scotland. In this regard, it must be remembered that many of these firms have established an important clientele, which has become familiar with a certain brand or quality, and many farmers are averse from a change of product. As distributive agencies for the several fertiliser products of Billingham, these firms are likely to be of distinct value.

Patent literature reveals that considerable attention has been directed to the production of diammonium phosphate and other concentrated fertilisers during the last twelve months. Several interesting methods have been developed.

What 1929 will bring it is difficult to say. The General Election will take place in May, and this may have a disturbing effect on the course of business. On the other hand, indications are not wanting which suggest that the prosperity of 1928 will be maintained in the New Year.

List of References.

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Recent Developments in the Solvent Industry

By Dr. J. Vargas Eyre

In view of the rapidly growing industrial demand for solvents for use in the production of lacquers, the following review by Dr. J. Vargas Eyre of the year's developments in the solvent industry is of particular interest and value, especially as the Distillers Co., with which Dr. Eyre is associated as Director of Research, seems destined to play a considerable part in the production of industrial solvents in this country.

THE use of cellulose ester lacquers continues to increase everywhere and this has naturally stimulated the interest in the solvents which are used in their manufacture. In addition to the well-known solvent esters, a large number of so-called "new solvents" have been put on the market, but on examination, one finds that these are, to quote a Spanish proverb, *Los mismos perros con cuellos nuevos*—the same old dogs with new collars.

A very large number of articles on solvents have appeared in the literature during the past year, but these are mostly either reviews or camouflaged advertisements of some particular type of solvent and for the most part they contribute little to our knowledge of the subject. A large number of patents have also been taken out for the manufacture and use of solvents and several of these present some points of interest. A considerable amount of work has been done, particularly in America, on the relation between solvent construction and solvent action, and in this connection articles by B. K. Brown in *Industrial and Engineering Chemistry* (1928, 20, 183) and by H. W. Woolff in the *Farbenzeitung* (1928, 33, 2228 and 2668) are worthy of mention.

Solvents of the Ketone Group

Of the solvents of the ketone group, acetone is, so far, the only one that is manufactured on a large scale, but it is possible that in the future the higher ketones may also become important in the manufacture of cellulose lacquers. The advantages of the ketones over other solvents are dealt with thoroughly by Despermet in *Cuir Technique* (1928, 21, 56). For the manufacture of acetone from calcium acetate, a specially constructed furnace has been patented by the Verein Chemische Ind. A.G., Czech patent application 1618, which, it is claimed, removes the difficulties of heat transference and loss of acetone which occur in the usual dry distillation method.

Several processes have been patented for the direct production of acetone from acetylene, acetaldehyde and ethyl alcohol and, if the claims made by the patentees are substantiated, these processes will become of considerable importance. It is claimed in British Patent 280,184 that acetone can be produced directly from acetylene by passing it with steam over a mixed catalyst consisting of iron oxide and an oxide of an alkaline earth metal, and in Canadian Patent 261,988 a similar catalyst is used for the production of acetone from ethyl alcohol or acetaldehyde and steam. In British Patent 282,448 a number of mixed solvents, including acetone, are said to be obtained by passing ethyl alcohol at a high temperature over barium oxide.

The production of higher ketones, particularly butyrone, from the distillation of calcium butyrate obtained by the fermentation of wood sugar or other similar materials, is said to have been developed in France, and several patents to cover different stages in this process have been taken out. The most interesting patent relating to acetone derivatives is that taken out by the I.G. Farbenindustrie A.G., British Patent 283,247, for the manufacture of dihydroxy acetone by fermentation. An article by Bernhauer and Schön on the mechanism of this fermentation, which shows that the claims of the patentees are justified if the right conditions are obtained, appeared in the *Deut. Essig. Ind.* (1928, 32, 337).

Fermentation and Synthetic Methods

There is little doubt that the usual methods for the manufacture of butyl alcohol and acetone by fermentation will have to compete with synthetic methods of producing these products. It would appear that there is little difference in cost between the two methods, although of course in certain localities one of the methods may have an advantage in this respect owing to local conditions in the cost of power, coal, etc., and in the supply of the raw materials available, but the fermentation method has the disadvantage that both butyl alcohol and acetone are produced simultaneously in a certain ratio. An interesting study of the organisms responsible for this fermentation was carried out by Mayer and Rettger (*Journal of Bacteriology*, 1928, 14, 399).

The production of butyl alcohol, synthetically by the oxidation of ethyl alcohol into acetaldehyde, conversion of this to crotonaldehyde, which on hydrogenation gives butyl aldehyde and then butyl alcohol, has been the subject of numerous patents during the year; and an alternative method of synthesis by distilling calcium butyrate obtained by fermentation with calcium formate and hydrogenating the aldehyde produced has recently been patented in France. It is claimed in Canadian Patent 282,383 that butyl alcohol and isopropyl alcohol without other compounds can be produced from carbohydrate materials by fermentation with a special organism.

Cracked Gases as a Source

The production of higher alcohols from petrol cracking gases is still hampered by the difficulty of purifying the products obtained, and although several patents have been taken out during the year for purifying and deodorising alcohols produced in this way, the problem seems to be far from solved. On the other hand, the production of amyl alcohol from pentane, particularly from that obtained from "casing head" gasoline and natural gases, has been successfully developed. The production by one company in America is said to be 115,000 gallons per month. The difficulties met with in the chlorination of the pentane and subsequent hydrolysis of the amyl chloride have been solved very ingeniously.

The glycols, as well as their esters and ethers, have become of considerable importance as solvents and a large number of processes for improved methods of manufacture have been patented. Among these, British Patent 286,850, Synthetic Ammonia and Nitrates, Ltd., seems to present decidedly novel features, whereas with most of the others it is difficult to see in what the novelty consists.

Synthetic Methanol

The synthesis of methanol from water gas has not led to the world-wide revolution in the production and use of this solvent that some people predicted for it, and it seems certain that improvements in wood distillation methods would enable methanol produced in this way to compete with the synthetic article. The chemistry of methanol synthesis has been the subject of a series of interesting articles, both in this country and in the United States. In this connection the work of Morgan, Taylor and Headley (*J.S.C.I.*, 1928, 47, 265T) and that of Lewis and Frohlich (*Industrial and Engineering Chemistry*, 1928, 20, 285) is particularly interesting.

Of the large number of patents that have been taken out for methanol synthesis, the only ones presenting novel features are those of the Commercial Solvents Corporation, British Patents 271,840, 279,378 and 279,377, in which the preparation and use of special catalysts for the production of methanol from oxides of carbon, particularly carbon dioxide and hydrogen, are described. The gases obtained in the butyl alcohol fermentation process are now being used for methanol synthesis. The production of methanol from methane by chlorination and hydrolysis of the methyl chloride produced seems to have made little progress, although a number of patents covering various stages of the process have been taken out.

Esters

The advantages of particular esters as solvents have been claimed in a number of articles and patents, but a review of all the literature of the year and a consideration of the basis of these claims makes one sceptical as to the superiority of any of them. The two most interesting patents for improvements in esterification are that of the Standard Development Co., United States Patent 1,651,666, in which the esterification is carried out in the presence of a solvent such as a highly refined petroleum in which the ester formed is absorbed and in which, it is claimed, extremely small amounts of catalyst are needed for esterification; the other is that of the Holzverkohlungs-Industries A.G., British Patent 295,275, in which esterification is carried out under pressure with small amonnts of an acid catalyst, the ester formed being continuously removed.

Little new has appeared with regard to solvent recovery, although various patents relating to improved plant have been taken out; none of these, however, presents any outstanding feature of interest.

Some extremely useful work on the toxicity of organic solvents and the precautions which are necessary when using them in the lacquer industry has been carried out by H. Smyth (*Journal of Industrial Hygiene*, 1928, 10, 261). The results obtained show that the air concentrations of the ester solvents usually employed are well within the safety limits, but that the proportions of butyl alcohol and of toluene now employed are very near the limits of safety for the workers.

The use of paracymene as a solvent in special cases has been the subject of several articles and patents, and there seems little doubt that its use is increasing.

A Year's Progress in Chemical Engineering

By S. J. Tungay

Closely associated from the outset with the development of chemical engineering in the modern sense, a keen student of corrosion problems, and an authority on and actual producer of acid-resisting materials, Mr. Tungay shortly indicates in this article the main lines of progress during the past year.

It would seem fitting that at the close of the year Professor W. E. Gibbs, who was recently appointed to the Ramsay Chair of Chemical Engineering at University College, London, should give a public inaugural address on the subject of chemical engineering education. During recent years, the importance of chemical engineering has been more than ever emphasised in this country; and in view of the progress and competition in the chemical industry, the study of chemical engineering is more than ever necessary.

This fact has been brought out again within the last few weeks by no less an authority than Lord Melchett. He points out in The *Times* International Chemical and Allied Industries Edition that when the question of technical balance in the industries is examined, it can be definitely stated that we are now engaged in serious scientific engineering and the full assistance of the engineering industry is now entirely at the disposal of the chemical industry. It is, in fact, essential, if we are to experience industrial prosperity in the chemical trades, to obtain the co-operation of the chemical engineer, who must concern himself with the detailed study of the various plant operations which will be found necessary to the successful working of a chemical industry. The day of the old-time chemical factory, when haphazard methods sufficed, is fast passing away. These may have served when prices for the finished products were good and competition in the chemical industry less keen than that experienced since the war period; but their day is virtually over. The modern tendency towards combination of those engaged in the chemical industry has in itself tended to demonstrate the need for the engineer in the design of plant and material of the most economic order for the production of chemical compounds, and for the successful commercial operation of chemical processes designed to enable us to compete with our competitors overseas.

Samples of Modern Progress

No one who has carefully studied the year's work of such bodies as the Institution of Chemical Engineers, or the meetings of the Chemical Engineering Group of the Society of Chemical Industry, can fail to be impressed with the fact that the chemical engineers in this country are a live body, and are fully alert to the necessities of the industry. When one considers such advances in chemical enterprise as that of the fixed nitrogen industry, which may be cited as an outstanding technical achievement in this country; when one glances at the advances of the last year or so in the viscose process and the development of the artificial silk industry; or, again, when one contemplates the marvellous painstaking and untiring energy devoted by our chemical engineers to the questions of low temperature carbonisation and low temperature tar products, work which has been pursued notwithstanding continued disappointment and set-back in past years; or finally, when one reviews the energy which has been applied to the production of synthetic alcohol, it is impossible not to be impressed with the progress that has been made in the development and perfecting of chemical engineering enterprise in this country.

In the many developments in connection with plant for the production of fine chemicals and pharmaceutical products

chemical engineers have been busy and are working hand in hand with the chemist to develop products new to this country and often new to the industry; indeed, each of the last few years since the war period has seen considerable modifications and improvements of such chemical works plant. Old processes are being scrapped, newer and more economic methods are being schemed and developed, and processes which could not have been worked ten or fifteen years ago upon a paying and remunerative basis are now functioning economically and without fear of competition in this or other European countries.

There has been evidence for some years past of a wider desire for exchange in ideas and closer collaboration among chemical engineers and those engaged in the manufacture of chemical plant. The British Chemical Plant Manufacturers Association has done much to bring about a happier state of affairs between the manufacturer of chemical plant and the chemical plant user. Processes and methods are discussed more openly, and the freer exchange of views has led not to greater competition but to a higher level of general knowledge, to the great good of the industry concerned.

Advance In Process Methods

Recent chemical engineering literature deals very fully with methods for the separation of solids from liquids, which covers a very wide field of application in chemical processes and plant design. The separation of solids from liquids is a most important item in many chemical processes, and calls for the chemical engineer's skill according to the methods which may require to be adopted. In some cases simple methods of gravity may be applicable, whilst in others more scientific methods of centrifugal separation may have to be applied. These methods of centrifuging have been developed from the crude form of hydro-extractor of years ago to a highly scientific installation or to a super-centrifuge of more complicated design, such as is now in continual operation in many chemical works.

Filtration schemes are many and varied, and the advances in filtration during the last year or so have called forth the highest skill of the chemical engineer.

Again, methods of evaporation of liquids from solids either for the purpose of separation or crystallisation continue to receive a good deal of study, and perhaps no section of chemical plant has been so greatly improved during the last ten or fifteen years as the types of plant designed for evaporation in the chemical industries.

It has long been recognised that this is a subject of such outstanding importance that it may mean the prosperity or the failure of an entire process or industry. Economical evaporation plant is called for by so many branches of the chemical industry that it has afforded the chemical engineer a field for the development of plant constructed on sound scientific lines.

Corrosion-Resisting Material

With all the progress and advance which is being made in the application of chemical engineering to industry, one ought to remember that such progress would have been impossible without the advance in the discovery and application of improved acid resisting metals and materials for the construction of plant and chemical works equipment. Perhaps there is no epoch during which the study of corrosion-resisting metals for the construction of plant has received closer research and attention than during the last decade. Acid-resisting alloys have received very wide-spread attention at the hands of research chemists and chemical engineers. There is a competition existing among the producers of such alloys and metals which would certainly not have been anticipated ten years ago.

The great improvements in ferrous alloys such as nickel-iron and chromium-steel, the extended use of copper-nickel alloys and chromium-nickel alloys for resisting chemical action or for sustaining high temperatures are gradually receiving wider application. The extended use of nickel, either alone or alloyed with other metals, is a most interesting factor in modern metallurgical application. The plating of metals for chemical plant construction also shows some advance during the last twelve months. The use of chromium plating is becoming more widely extended, and a recent interesting patent shows us a plating of silver with magnesium, arsenic, or antimony, as a plating for resisting corrosion by hydrochloric acid.

The production of homogeneous lead lining for chemical vessels is being more widely undertaken in this country than ever before. Some vessels inspected by the writer in the course of lining in the London area a few days ago appear to leave nothing to be desired from the point of view of homogeneity of the lead lining, and, indeed, are fully equal to any similar work of continental production.

Many persons have recently been impressed with the number of new industrial undertakings which are being established in connection with the chemical and allied trades, particularly in the London area and South of England districts. With improved economic electric power available, the tendency of many of these industries is to develop in the London and southern area instead of being necessarily located in the vicinity of coal producing districts as formerly.

The development in metallurgical processes also continues, and the progress and advancement of these twin industries, chemical and metallurgical, reacts beneficially on the position of each.

The past year has much to show us of progress due to chemical engineering, and whilst there may be no boom in the chemical industry, advance is sure and certain. The unemployment figures are not too bad, the industry is very much alive, and its engineers are keen and alert.

Sampling and Analysis of Coal

Meeting of B.E.S.A. Committee

A MEETING of the committee governing the work of the British Engineering Standards Association on the sampling and analysis of coal was held a short time ago, at the Institution of Civil Engineers, when reports from the various sub-committees and panels which had been studying the details of the problem during the past few months were presented.

Although Mr. Ridley Warham, the chairman of the Sampling Committee, was not able to present any very definite report, the problem, complex as it is, is being fully explored with every prospect of ultimate success. In the meantime, certain tentative proposals for both chute and truck sampling have been put forward. Mr. Clay, the chairman of the analysis committee, reported that the panels dealing with moisture, volatile matter, ash, sulphur, calorific value, agglutination, phosphorus and arsenic had all been working hard, and had made unexpectedly good progress.

On the whole, the technical committee was well satisfied with the general progress so far made, and at the meeting which it is proposed to hold towards the end of February it is hoped that the sub-committee and panels will be in a position to submit definite proposals.

Canadian Fertiliser Industry

THE production of complete fertilisers in Canada last year amounted in value to $1,670,507. In addition, fertiliser materials such as ammonium sulphate, calcium cyanide, animal tankage, ground bone and fish fertilisers were produced in plants classified under other industries; in 1927, the value of these commodities was $6,278,707.

The twelve plants engaged in the manufacture of complete fertilisers as their chief product were distributed as follows: Ontario, 6; Nova Scotia, 2; British Columbia, 2; Quebec, 1; and New Brunswick, 1. They represented a capital investment of $1,998,811.

Superphosphate was produced in only one plant, but was sold to a number of other firms, after dilution with a filler to meet requirements of the trade. One company was engaged solely in grinding and preparing basic slag. The complete fertiliser produced in other indutries amounted to 22,000 tons, valued at $876,524.

Fertilisers and fertiliser materials to the value of $4,138,053 were imported last year, which total included superphosphate, manufactured fertilisers, sodium nitrate, muriate and sulphate of potash, basic slag, and ammonium sulphate. Exports were worth $5,379,582, and included cynaamide, ammonium sulphate and manufactured fertilisers.

Synthetic Resins: A Year's Progress

By Alan A. Drummond, M.Sc.

The principal recent developments in the important field of synthetic resins are briefly and clearly summarised in the following review by one of the leading authorities on the subject. It shows that while unabated interest continues in the original Bakelite resins, resins of several other types are being produced or studied, and indicates the wide fields of industrial application that yet remain open to such products.

TWENTY years ago, little mention would have been found in the technical press of the subject of synthetic resins. It was only after Dr. L. H. Baekeland had brought his enthusiasm and skill to bear upon the previously little-regarded resinifying reaction between phenol and formaldehyde that synthetic resins began to impress the industrial world as possible new raw materials of wide commercial application. Nowadays, the term "synthetic resin" may even be regarded as having reached the ear of the "man in the street," not to mention the lady buying Christmas presents at Selfridge's. To the latter, at any rate, the term has some intelligible interpretation in the form of an artistic flower or powder bowl.

"Bakelite" and Other Resins

Synthetic resin and "Bakelite" are perhaps synonymous in the popular mind. At the present time, however, many varieties of artificial resin other than those of the Bakelite type are not only being studied in the laboratory but are developing rapidly in the factory. The world's production of artificial resin and compositions containing it amounts to something like 13,000 tons per annum, of which Great Britain manufactures perhaps 600 tons.

The published literature of the year, including patent claims, shows that unabated interest continues in the resins of the Bakelite type, namely, those prepared from phenolic compounds and formaldehyde.

New methods are being tried for the substitution of formaldehyde by other aldehydes such as acetaldehyde (U.S.P. 1,653,302), and butaldehyde (U.S.P. 1,667,872). Methylal, when boiled with phenol in the presence of sulphuric acid, has been found to give a hard, fusible, brittle resin (U.S.P. 1,645,226).

There is an effort to provide phenolic resins of a more standardised character. Dr. E. E. Walker, in association with the British Dyestuffs Corporation (B.P. 296,514, 1927), has protected a process for purifying resins and resin compositions by which free phenols and soluble condensation products are extracted with a solvent (water, benzene). F. Seebach purifies fusible, soluble phenolaldehyde resins by treating the resin with not more than an equal part of water, and with sufficient alkali to form a colloidal suspension, and then precipitating the resin by adding salts which have the property of salting it out (U.S.P. 1,681,369; see also U.S.P. 1,681,368). A paper issuing from the Chemical Research Laboratory of the Department of Scientific and Industrial Research records that dielectric strengths of 1,000 volts/mil. have been obtained in the laboratory with resin mouldings prepared with phenolic resin from which all non-resinifying constituents have been removed (*Trans. Inst. Rubber Ind.*, 1928, **4**, 40).

From a more purely scientific aspect of investigation, J. Novak and V. Cech (*Ind. Eng. Chem.*, 1928, **20**, 796) have endeavoured to find some objective method for determining the degree of resinification of a reacting phenol-formaldehyde mixture. Three methods are used: (1) Measurement of the refractive indices of the reaction mixture; (2) Determination of the viscosity of an alcoholic solution of the mixture; and (3) Determination of "bromine value" of the mixture.

Formaldehyde-phenolic and Urea-formaldehyde Types

As is well known, formaldehyde-phenolic resin, as usually obtained, suffers from the disadvantage of not being miscible with varnish oils, and the patent claims show a determined effort to surmount this difficulty and thus to obtain products which will compete with the oil-soluble Albertols and Amberols. By boiling phenol with China-wood oil, in the presence of phosphoric acid, V. H. Turkington and the Bakelite Corporation (U.S.P. 1,677,417) claim to obtain a product which can be condensed with formaldehyde in the presence of natural resins to produce a valuable varnish. The Bakelite Gesellschaft (B.P. 282,414) prepare oil-soluble phenolic resins by heating phenol-formaldehyde resin of the heat-hardening type with high-boiling polyhydric or polycyclic alcohols.

Resins of the urea-formaldehyde type (Beetle, Pollopas, etc.) have received during the year considerable attention. The development of applications of these resins has been remarkably rapid, particularly in this country. The outstanding feature of such resins is their colourless appearance, and for this reason they are being successfully employed in the "filled" condition as the basis for delicately-tinted moulded tableware, flower bowls, cups and saucers, and similar articles. "Beatl" and "Bandalasta" ware of this type are prepared from the resin obtained from formaldehyde and thiourea by the Beetle Products Co., of Wolverhampton. Thiourea is obtained from the gasworks by-product ammonium sulphocyanide, and the Beetle Co. have contracts with the Birmingham Corporation for the supply of this product. A urea-formaldehyde condensation resin patented by Dr. Pollak is being developed by a syndicate formed in Great Britain; their endeavour, assisted by Professor Baly, is to produce, amongst other products, the much desired "flexible glass." Many refinements in methods for the control of the condensation are described in the patent literature published during the year. The following numerous patent numbers belonging to the I.G. Farbenindustrie A.-G. indicate German interest in this class of resin: B.P. 258,289, 259,950, 260,253, 261,029, 264,466, and 266,752. Numerous other processes for preparing these resins have been protected but cannot be dealt with in this brief survey.

Glyptals

Resins produced from the reaction between polyhydric alcohols (such as glycerol or glycol) and polybasic acid anhydrides (such as phthalic anhydride) have also made rapid progress, sponsored by the General Electric Co. in America and the British Thomson-Houston Co. in this country. The Du Pont Company are also preparing and marketing these resins (known as "glyptals"), particularly for application in varnishes. They claim that by their use drying time is shortened, and flexibility and durability are increased. Some indication of the extent to which development of these resins is expected is seen in the fact that the Monsanto Chemical Works of St. Louis completed, some months ago, an addition to its phthalic anhydride department, giving it double its former capacity; moreover, by the end of the year it is hoped that the capacity will be three times that of a year ago. Recent patents are chiefly connected with methods for the incorporation of drying oils and drying oil acids with glyptal resins, and for the substitution of glycerol by pentaerythritol.

Laboratory Research for New Products

The resins dealt with in the foregoing paragraphs, together with those from polymerised coumarone and indene, represent the main classes of resin at present holding the field commercially. There are, however, a variety of other types receiving close attention in the laboratories of the leading countries of the world. H. A. Gardner draws attention in a recent Circular (No.337) of the American Paint and Varnish Manufacturers' Association to the industrial possibilities of the water-white polymerisation resin from vinyl chloride or acetate. The extent to which these products may ultimately be used in the paint, varnish and lacquer industry will, of course, depend upon the price at which they may be commercially produced. There is apparently some difficulty in reproducing batches of uniform quality. Dr. Gardner has found that with samples in his possession films of good durability can be prepared.

Acetone and aldehydes will react under the action of acid or alkali to form a resin soluble in hydrocarbons and esters. H. A. Gardner and C. A. Krauss (*Ind. Eng. Chem.*, 1928, **20**, 599) have investigated these to some extent, and were able to prepare a product combined with rosin which, as a lacquer, showed a durability fairly comparable to that of the lacquers produced from ester gum and damar, but which was considerably darker in colour.

Resins insoluble in acids, alkali, and ethyl alcohol have been obtained recently, by P. H. Groggins (*Ind. Eng. Chem.*, 1928, **20**, 597) by the controlled chlorination of *p*-cymene. The resins produced from low-temperature chlorination, in which ring-chlorine substitution is the primary action, are more stable than those which contain a preponderance of side-chain chlorine. Suggested uses for this new resin are in connection with marine work and chemical plant; the solutions of the resins may also be used with advantage in the treatment of railroad ties and telephone poles. Electrically they have shown the following values: dielectric constant, 2·5; power factor, 3·0 per cent.; resistivity, 10^{14} ohm. cm.; dielectric strength, 20,000 volts/mil.

This review deals very briefly with the rapid developments taking place with synthetic resins. New openings for their application are continually being revealed; for example, the need is growing for transparent, colourless cementing compositions for the popular laminated splinterless glass. Moreover, when the rapidly-growing gramophone record industry finds its supplies of shellac becoming short (a situation that will occur, according to a recent estimate, in five years) artificial resin will doubtless enter a further rich field of application.

Recent Developments in Fertilisers

By A. B. Bruce, M.A.

As Mr. A. B. Bruce, of the staff of Nitram, Ltd., indicates in the following, the proper handling of the fertiliser problem involves a large amount of research not only in chemistry and chemical engineering, but also in agriculture.

In an article which appeared in last year's Annual Review Number under the above title, reference was made to the problems that have arisen in connection with synthetic, or "concentrated," fertilisers as they are called in the United States.

During the last twelve months, these problems have become more definite. Extensive trials carried out by the Agricultural Research Department of Imperial Chemical Industries, Ltd., go to show that the new fertilisers, so far as crop yields are concerned, give results as good and sometimes better than mixtures of standard fertilisers of equivalent chemical composition. The way is now clear for the study of incidental problems connected with the introduction of these new products on the world markets. Of these the most pressing is the question of balance of ingredients, that is, what should be the relative proportions of the occupants of the fertiliser triangle, of N, P, and K, in a complete manure, and in what chemical and physical condition shall the components be presented? It cannot, of course, be expected that the ideal ratios shall remain the same under all variations of soil and climate, but it is obvious alike from experiment and experience that the number of combinations offered can be limited, and the problem is to determine the smallest number that will meet the varying conditions of husbandry. It is not every farmer who is skilful enough to call for the exact combination best suited to his soil. What is wanted is a mixture suitable for ordinary purposes, leaving it to the learned man to adjust the standard to meet any special conditions, by adding one or other single ingredient until the balance is to his liking. It seems probable, too, that such broad divisions of standard crops as cereals, "roots," and grass will each demand their own special ratios. In the meantime, field experiments are adding to our knowledge on the subject of "balance."

Results of Trials

Striking results have recently been obtained in relation to the manurial needs of fruit trees. It has been shown, for example, that all the symptoms of nitrogen starvation may persist in spite of repeated applications of nitrogenous manures unless the store of potash in the soil is supplemented. With the restoration of the balance, the nitrogen becomes effective. Again, in relation to potatoes an extensive series of trials, carried out in Scotland last season, has shown—what has already been demonstrated in Lincolnshire—that much heavier applications of sulphate of ammonia than has hitherto been customary will give a profitable addition to yield, provided that sulphate of potash is added *pari passu*. Another remarkable example of complementary action is furnished by a report on a large number of official trials of fertilisers on rice in Burma. It was found that a balanced mixture of sulphate and phosphate of ammonia giving equal amounts of nitrogen and phosphorus pentoxide often doubled the yield of rice.

Field trials all over the country last season have also justified the expectation that a mixture of nitrate of ammonium and calcium carbonate would prove to be a valuable "top-dressing," that is for surface application to growing crops. This substance has been named "Nitro-Chalk!" It has two useful properties; it contains both nitric and ammoniacal nitrogen; and the calcium content prevents the ammonium ion from robbing the soil of that element in the course of nitrification. (It should be noted that the grade of Nitro-Chalk to be marketed in future will contain the same proportion of nitrogen (15·5 per cent.) as the "Chile Saltpetre" so familiar to the agriculturist.) It has long been known that both forms of combined nitrogen fulfil useful functions; the nitric is quick-acting, but quickly washed out by rain; the ammoniacal, though slower in coming into initial action, is held in the soil, and is available as a more lasting stimulus to continued growth. It is also supreme in tropical regions with a heavy rainfall.

China and Japan

Nothing in the history of chemical fertilisers is more remarkable than the post-war demand for sulphate of ammonia from rice-growing countries. The peasants of China and Japan have at least two thousand years' experience behind them, and, as a consequence, have become the most skilful plant husbandmen in the world, particularly in regard to one of the fundamental requirements of agriculture, the production and conservation of "natural" combined nitrogen. They regard our elaborate sewage systems with an almost pious horror—a wanton waste of the gifts of God; and well they may, for they succeed in feeding their pullulating populations by religiously returning to the soil every scrap of animal and plant waste that can be laid hold of, even at the expense of Western notions of decency. It is, therefore, no wonder that they are avidly importing combined nitrogen, and that the Japanese with characteristic mimicry of the West are establishing synthetic ammonia plant as rapidly as may be.

In conclusion, it may be of interest to mention some of the research problems with which the manufacturers of concentrated fertilisers are likely to be faced. The hydroscopicity of fertiliser mixtures, affecting as it does the storage, transport and field distribution of the material, demands insistent investigation. Again, the impurities (from one viewpoint) present in many of the organic residues from which standard fertilisers are derived may, for all we know, play important parts in plant nutrition.

Lastly, a number of problems arise in connection with the physical condition of the materials in relation to the mechanics of distributing machines.

Talc and Soapstone in Canada

Talc and soapstone production in Canada during 1927 amounted to 16,521 tons valued at $236,105, according to finally revised statistics just issued by the Dominion Bureau of Statistics at Ottawa. In 1926 shipments were recorded at 15,767 tons worth $217,195. Ontario's production was made up of talc obtained from deposits near Madoc, Hastings county, and soapstone from the Grace mine near Vermilion Bay. Quebec shipments were from quarries in Broughton, Leeds and Thetford townships, and consisted principally of soapstone blocks for use in lining the alkali recovery furnaces of sulphate (kraft) pulp mills. Small shipments of talc were made from two deposits in British Columbia, one located on Vancouver Island and the other near Wilmer, Windermere mining division. Talc or soapstone, ground or unground, imported into Canada during 1927 amounted to 4,907 tons appraised at $86,858. Exports of refined talc totalled 10,692 tons worth $125,123.

Medicinal Chemicals in 1928

By G. Malcolm Dyson, Ph.D., A.I.C.

Apart, perhaps, from the liver extract treatment of pernicious anæmia, there have been no sensational developments of chemotherapy during the past year. The following review indicates, however, that steady progress is being made.

In chronicling progress in medicinal chemicals, it is seldom that one is able to point to a particular substance and state categorically that such and such a compound marks a definite advance in the treatment of some condition or infection. Each year, a multitude of new preparations is placed on the market, each with an ever-increasing bundle of semi-technical "literature" designed to persuade the user that the compound in question presents the best method of combating some form of disease. The ultimate test is time, and new drugs are very slow to gain an accepted place in the armamentarium of the clinician unless they possess a rapidly demonstrable "specific" action, as for example, that of quinine against malaria, of antipyrine in certain nervous conditions, and of "Bayer 205" in trypanosomiasis.

Synthetic v. Natural Products

One of the tendencies of modern chemotherapy which has been well to the fore in the past year is the consistent replacement of natural products by identical synthetic substances at a price which competes favourably with that of the natural article. It will be noted with considerable pleasure by chemists that the price of synthetic thyroxin, introduced last year, is now half that of the natural product obtained by the extraction from animal glands. Another case in point is the replacement of natural ephedrine by the synthetic ephetonine (Fig. 1).

There are two particular directions in which such substitutions must ultimately run, namely, the replacement of insulin and the active substance of liver extract by the synthetic substances. The work published during the year has done but little to establish any sort of clues as to the nature of insulin. Certain workers claim to have isolated the amino-acid units lysine, arginine and cystine from insulin by hydrolysis, but the majority of biochemists are agreed that other and hitherto unrecognised degradation products must have been obtained in addition. Again, it has been suggested that the efficacy of insulin is due to the presence of substituted guanidyl groups, as in the case of synthalin (diguanidyldecamethylene), but apart from the isolation of arginine (Fig. 2) there is no evidence for this.

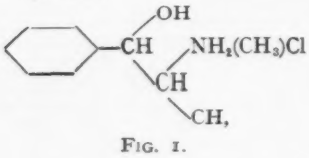

Fig. 1.

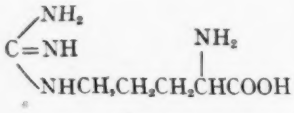

Fig. 2.

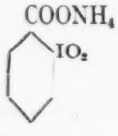

Fig. 3.

Synthalin

As was suggested in the summary on "Medicinal Chemicals in 1927," synthalin has not proved to be capable of replacing insulin universally since there appears to be a fundamental difference between the actions of the two compounds, apart from the toxic action of the synthetic compound. Professor Dale, in his pharmacological examination of the action of synthalin, has recently shown that there was no storage of glycogen in either the liver or the muscles during its action, and his impression is that synthalin causes a great fall in the blood-sugar only when the dose is large enough to inflict serious functional damage on the liver.

One of the more important developments of the past year is to be noted in the definitely established position which liver preparations have taken up in connection with the treatment of pernicious anæmia. It is also gratifying to observe that the "whole liver" treatment of 1927 has been superseded by the preparation of an active water-soluble liver extract. The advantage of this is easily seen when it is realised that under the older system the patient had to consume half a pound of raw or lightly cooked liver a day. The value of the extract

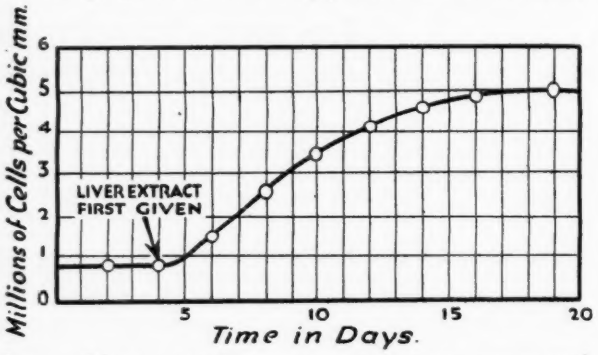

Fig. 4. Increase in Reticulated Red Cells under the Influence of Liver Extract.

may be gauged from the above graph (Fig. 4) which illustrates the enormous increase in the reticulated red cells of the blood (deficient in the case of pernicious anæmia) under the influence of liver extract. The problem is an object lesson for those who say that organic chemistry is "played out." Here we have, in a common substance such as liver, some compound capable of relieving this hitherto incurable malady; one cannot help feeling that the isolation, analysis, and synthesis of this compound will form one of the most thrilling chapters in the history of organic chemistry.

Iodine Compounds

A third trend in the recent history of medicinal chemicals is the increasing attention which is being paid to iodine compounds in chemotherapy. It has, of course, been realised since the first uses of elementary iodine and of iodoform that strong antiseptic properties are characteristic of iodine and its compounds. Recently, tetraiodophenolphthalein has been successfully applied in X-ray technique for choleocystography, while iodipin and its allies (mainly the iodine addition compounds of unsaturated oils, *e.g.*, rape oil) have been put to a variety of medicinal uses.

This year has been marked by the adoption of the ammonium salt of ortho-iodoxybenzoic acid (Arthrytin) (Fig. 3,) as a specific remedy for arthritis. This substance appears to be the first iodoxy compound to be seriously applied in chemotherapy, and some speculation is natural as to its chemical method of action. One suggestion is that it is degraded to iodobenzoic acid and thence to salicylic acid; but this has not yet been demonstrated under biochemical conditions.

Organo-Metallic Compounds

Among the host of organo-metallic compounds which have been introduced into practice during the last year or two, very few present features which mark them out from the commonly accepted arsenicals, antimonials and mercurials. One exception is the new diuretic Neptal (440–B), which is obtained by the mercuration of salicyl-allyl-glycine with mercuric acetate. This substance produces a profound diuresis and an increase in the total quantity of chlorides excreted, and is therefore valuable in the treatment of cirrhosis.

Among the smaller matters of medicinal chemical interest is the recent discovery of a hitherto unsuspected impurity in anæsthetic ether, namely, vinylethyl ether. This substance, which is definitely more toxic than ordinary diethyl ether, forms a potential source of danger.

On the whole, one may, perhaps, describe the progress in medicinal chemicals in 1928 as being unexceptional. It is true

that increasing attention is being paid to chemotherapeutic work; but there is no doubt that (to use the words of a celebrated pioneer investigator) the nation is, to a considerable extent, sponging on the private individual as far as this type of research is concerned. The protection of health is so much a national matter that it would seem not only desirable, but necessary, that the nation should invest in research on the application of medicinal chemicals to its own welfare.

[NOTE: In the Report of the Committee of the Privy Council for Scientific and Industrial Research for 1926-27, published in February of this year, it was recommended that a chemotherapy committee be set up. It was to consist of chemists and biologists, who would develop and co-ordinate chemical and biological research now in progress in this country. The formation of a clinical committee, for testing purposes, was also recommended.—EDITOR, *C.A.*]

A Review of Chemical Invention in 1928

By Our Patents Correspondent

This valuable review deals in detail with the more important chemical inventions patented during the year. Attention is drawn as in previous years to the enormous proportion of British chemical patents that originate and are owned abroad, mainly by Germany. The patents taken out by the I.G., for example, are now about 1,300 per annum.

THE year now drawing to a close has witnessed more invention in the chemical industry than any preceding year, and there is now no industry in which organised research plays a greater part. Indeed, the only other industry which is at all comparable in this respect is the electrical industry, and both are noteworthy for the organisation and co-operation which exist within them.

A notable feature is again the big increase in the number of inventions from Germany, which may be illustrated by the figures for one organisation, the I.G. Farbenindustrie Akt.-Ges. These figures have risen from (in round figures) 200 in 1925, 400 in 1926, and 800 in 1927, until they are now at the rate of about 1,300 per annum. Our own counterpart, Imperial Chemical Industries, is now making applications for patents at the rate of about 160 per annum. A study of the representative selection of British patents abstracted in the Patent Literature columns of THE CHEMICAL AGE during the year reveals the fact that of these inventions about 89 per cent. originate and are owned abroad. By far the largest proportion come from Germany, with Switzerland, France, and the United States providing only a few. The figures are significant of the value attached to patent protection, not only for inventions whose importance is obvious, but for those which, apparently small in themselves, may form the starting point in a line of research.

In view of the enormous mass of material, selection of patents for special notice becomes increasingly difficult, and many of real value must necessarily be crowded out. Where possible, the number of the invention referred to is given in parenthesis.

Hydrogenation of Coal

The hydrogenation of carbonaceous materials continues to occupy a prominent place in chemical research work, and while some inventors are concentrating on the details of established processes, others are attempting new methods. Thus, hydrogenation of carbon or hydrocarbons can be effected by an electric arc, or sparks from a condenser discharge between electrodes in a liquid which is a solvent for the products (284,655, XVIII, 327), while coal and petroleum distillates can be hydrogenated by hydrides of alkali and alkaline earth metals at a pressure of 100 kilos and temperature below 300° C. (286,206, XVIII, 417). Products ranging from benzene to heavy oils are obtained, and the process has the advantage that it is not affected by the presence of sulphur compounds or other contact poisons. In another invention (281,298, XVIII, 104) products of hydrogenation of carbonaceous materials are further treated with excess of hydrogen at 500°–1000° C. and 10–200 atmospheres pressure, in the presence of chromium or manganese oxide, but not iron or nickel, to obtain benzene, naphthalene, anthracene, and phenanthrene.

A number of inventions relating to the apparatus for hydrogenation have been patented, notably one in which the apparatus is constructed of chromium, manganese, or tungsten, or special steels such as Krupp V2A (282,384, XVIII, 183) and another, particularly for treating oil, tar, resin or asphalt, constructed of manganese bronze (282,814, XVIII, 224). In another case (283,177, XVIII, 225) the hydrogenation is effected in a high-frequency magnetic field. A large number of new hydrogenation catalysts have been patented.

Fertilisers

This branch of the industry has shown increased activity, notably in the production of composite or mixed fertilisers, and fertilisers having a minimum of "ballast" or inactive material. Thus, in one case (290,075, XVIII, 554) mineral rock phosphate is powdered and heated under reducing conditions with potassium sulphate or bisulphate to obtain a product which contains water-soluble potash and phosphate, water-insoluble, but citric acid-soluble phosphate, and sulphides which are removed. The product is treated with a fertilising acid or acid salt such as phosphoric acid obtained by treating phosphate rock with sulphuric acid. An ingenious method for obtaining a concentrated mixed fertiliser (295,477, XIX, 266) consists in treating potassium chloride with calcium fluoride, silicic acid, and hydrochloric acid to obtain potassium fluosilicate, which is treated with aqueous ammonia to obtain potassium and ammonium fluorides, with a deposit of hydrated silica which is used again in the first reaction. Raw phosphate is treated with nitric acid and the solution added to the mixed fluorides. The mixture is neutralised with ammonia, and the solution then contains only potassium and ammonium nitrates and phosphates.

Another process involving the treatment of crude phosphate with nitric acid (294,117, XIX, 296) employs acid of such strength that the product has less than the normal water of crystallisation. The resulting mixture of calcium nitrate and phosphate does not readily become damp. Potassium nitrate is obtained, according to another invention (286,172, XVIII, 304), by heating potassium chloride and silica to obtain the silicate, dissolving in water, and treating with carbon dioxide to obtain the carbonate, and then treating with calcium nitrate to obtain the nitrate. Another process for the production of alkali nitrates (283,771-2, XVIII, 149) consists in the treatment of alkali metal chlorides with nitric acid or nitrogen oxides, whereby hydrogen chloride is expelled and residual nitrogen oxides are absorbed by sulphuric acid at 6–20 atmospheres pressure to form nitrosulphuric acid. The increased pressure does not increase the solubility of hydrogen chloride. The chloride solution may be of such strength that the nitrate is deposited in the solid state.

The manufacture of ammonium sulphate has been improved in a number of details, mainly in the plant used, but some new methods have also been employed, notably one (292,129, XIX, 145) in which ammonia gas is treated with a spray of sulphuric acid of such concentration that the heat of the reaction vaporises the water and leaves a dry salt. A novel process for fixing atmospheric nitrogen (283,232, XVIII, 126) consists in the treatment of finely divided lime and calcspar with superheated steam and preheated air at a temperature of 900° F. and pressure of 4-5 atmospheres. Copper or zinc is used as a catalyst, and an electric potential difference of 80 volts is applied between suitable electrodes. The solid material is then subjected to the action of hot and cold air and to a potential difference of 90 volts, with a nickel or copper catalyst.

Indiarubber

Inventions relating to indiarubber originate mainly in America, the principal object of research being the acceleration of vulcanisation and prevention of ageing of the rubber. For accelerating vulcanisation the aryl-mercapto-thiazoles have been used (282,947, XVIII, 126 and 283,661, XVIII,

149) and for preserving rubber, phenyl-α- or β-naphthylamine. There has been a revival of interest in synthetic rubber obtained from butadiene, dimethyl-butadiene and isoprene (283,840–1, XVIII, 271) sometimes in the presence of salts of cobalt, lead, manganese, chromium, nickel, and other metals (294,661, XIX, 323).

New methods of vulcanisation with a mixture of sulphur and selenium (290,602, XIX, 57) and with compounds obtained from hydrogen selenide, ammonia, and aldehydes (291,438, XIX, 126) are of interest. There has also been considerable activity in the electro-deposition of rubber, and other methods for the direct production of rubber articles from the latex.

Some Synthetic Products

A large number of patents relate to the synthesis of many of the commoner organic substances. Thus, in one invention (280,184, XVIII, 35) acetone is obtained by the reaction of acetylene and steam at 400° C. in the presence of iron oxide whose activity has been increased by a "promoter" such as iron, manganese oxide, aluminium oxide, barium or zinc carbonate, or calcium or magnesium oxide. In another case (288,707, XVIII, 462) a mixture of acetylene and steam is passed into a dilute acid containing a mercury catalyst to obtain acetaldehyde, ethylidene-diacetate, acetone, etc. Several processes relating to the production of olefines have been noted, notably one (291,867, XIX, 34) in which a mixture of hydrogen with excess of carbon monoxide is used, with a catalyst consisting of a mixture of oxides of copper, cobalt, and manganese, which has been reduced in hydrogen. Again, ethylene can be obtained by hydrogenation of acetylene in the presence of a palladium catalyst (294,787, XIX, 195) deterioration of the catalyst being prevented by supporting it on kieselguhr in an inert liquid such as deca- or tetrahydronaphthalene, and passing the gas through it in finely divided condition.

Low boiling hydrocarbons are obtained from olefines (291,137, XVIII, 614) by heat and pressure, employing catalysts of gold, silver, or copper having coherent surfaces, or compounds of alkali metals or metal salts of oxyacids of phosphorus, boron, etc.

A somewhat similar invention (297,179, XIX, 398) is that in which water gas is treated above 300° C. and a pressure of 10–15 atmospheres with a catalyst of iron and silver to obtain gaseous olefines and methane homologues, the gases being then heated to 600—800° C. with a copper catalyst. Liquid products are obtained containing 80 per cent. of benzene. An interesting process resulting in the production of diethylamine, methyl-pyridines, etc., employs a mixture of acetylene and ammonia with an inorganic salt capable of forming an addition compound with ammonia, such as zinc chloride, with or without ferric chloride; or cadmium or cuprous chlorides.

The synthesis of methanol is not represented by as many patents as formerly, although several new catalysts have been described. Attention has, however, been directed to some considerable extent to the production of pure hydrogen which is required in this connection and also in the synthesis of ammonia. An example of such processes (297,135, XIX, 398) is that in which a mixture of carbon monoxide and oxygen is passed over coal heated to 1,000° C. Any sulphur dioxide or carbon dioxide in the product is absorbed in alkali, and the carbon monoxide treated with steam in the presence of a catalyst to obtain a mixture of hydrogen and carbon monoxide.

Fixation of Nitrogen.

There have been a few cases of improvements in fixation of atmospheric nitrogen in the form of cyanamides, while in another case (281,611, XVIII, 104) cyanamides are obtained by heating oxides, formates, or carbonates of alkaline earth metals or magnesium with ammonia and carbon monoxide to 400—850° C. in the presense of water. By passing the gases over the products of this reaction at 700—800° C., hydrocyanic acid is obtained (282,379, XVIII, 183). In another example of hydrocyanic acid synthesis (296,355, XIX, 441) gases containing methane and nitrogen are treated in a flaming arc to obtain a mixture of hydrocyanic acid and acetylene, which are absorbed in alkali, and water under pressure, respectively. Several inventions for obtaining carbon disulphide of high purity have been patented, notably one (293,172, XIX, 104) in which methane and sulphur-containing gases with or without oxygen, react in the presence of aluminium oxide, active carbon, silica gel, etc., at 1,000° C.

The output of inventions relating to new dyestuffs and intermediates and to new dyeing processes has continued at a rate greater than that of the preceding year. This increasing activity is, of course, due in large part to the present stage of rapid development in the artificial silk industry. It is to be noted in this connection that each of the two main varieties of artificial silk presents its own peculiar problems to the dyestuff chemist. In the case of the regenerated cellulose silks (viscose, etc.) attention is being directed mainly to discovering new substantive dyes which are capable of producing level shades on such materials, and to the selection of known direct cotton dyes for this purpose (296,803, XIX, 346; 296,047, XIX, 296; 294,922, XIX, 218; 294,284, XIX, 172; 286,717, XVIII, 463; 286,226, XVIII, 417; 285,812, XVIII, 397; 281,767, XVIII, 34). The dyes are almost without exception of the azo (usually disazo) class, the coupling components being usually one of the aminonaphthol-sulphonic acids, γ (2 : 8 : 6-acid), J (2 : 5 : 7-acid), S (1 : 8 : 4-acid), or H (1 : 8 : 3 : 6-disulphonic acid). In the case of the cellulose ester silks, on the other hand, the problems which the inventor is attempting to solve are more varied. They include the discovering of suitable new dyestuffs of various types, especially azo dyes (295,237, XIX, 242; 294,284, XIX, 172) and anthraquinone derivatives (291,814, XIX, 34; 289, 807, XIX, 11; 285,096, XVIII, 348; 284, 242, XVIII, 305; 282, 853, XVIII, 102) and the selection of groups of dyestuffs not necessarily new, which are specially suitable for cellulose ester materials owing to the presence in the molecule of certain specified substituents (295,257, XIX, 347, 290, 720, XVIII, 580; 282,683, XVIII, 204). Numerous inventions have also been directed to the improvement of the technique of the known dyeing and printing processes in their application to cellulose ester materials.

Azo Dyes.

Turning to the production of such azo dyestuffs as are intended to meet requirements other than those of the artificial silk industry, we find a remarkable spurt of activity in connection with the production of soluble complex compounds of azo dyes containing metal, chiefly the metals chromium and copper (297,722, XIX, 418; 296,616, XIX, 346; 296,310, XIX, 441; 295,944, XIX, 399; 295,594, XIX, 369; 295,050, XIX, 347; 294,743, XIX, 194; 294,583, XIX, 323; 292,660, XIX, 84; 292,344, XIX, 84; 290,179, XIX, 35; 289,094, XVIII, 615; 288,307, XVIII, 555; 283,979, XVIII, 182; 282,783, XVIII, 205; 282,107, XVIII, 150). Such complex metal compounds are valuable in that they enable the production by direct dyeing methods of the fast dyeings usually obtained by after-chroming or after-coppering. The parent dyestuffs must, of course, contain groups capable of being chromed or coppered such as ortho-oxyazo or ortho-carboxyazo groups. In some cases the chromed or coppered dyestuff is claimed as new, but many inventions are directed to new processes for effecting the chroming or coppering operation. Many recent specifications refer to the special suitability of these dyestuffs for colouring lacquers and varnishes.

There have also been developments during the year in connection with those azo dyes derived from aminodiarylsulphones and aminodiaryl-sulphides which, due to the separation of a chelate (o-oxycarboxy) group conferring mordant-dyeing properties, from the chromophoric group by the —SO_2— or—S—bridge, yield dyeings which are practically unchanged in shade when their fastness is enhanced by after-chroming (297,855, XIX, 418; 288,788, XVIII, 494). The number of specifications relating to the production of azo dyes on the fibre (azoic or ice-colour process) continues to be large. Many of these inventions are concerned with the improvement of the dyeing process rather than with the use of new components or of new combinations of known components; and in particular, the technique of printing and stencilling by this process has recently received much attention. A few inventions have related to the production of stable diazo compounds for use in the process (280,945, XVIII, 85). As coupling components the arylamides of 2 : 3-oxynaphthoic acid and those of acetoacetic and like β-ketocarboxylic acids, which have such pronounced affinity for cotton fibre, continue to hold first place. Among recent new azo dyestuffs produced in substance, on a substratum, or on the fibre, are to be noted the insoluble products obtained by coupling such components with diazotised aminonaphthol ethers (294,291, XIX, 172), diazotised monoamino-carbazoles, and tetrazotised 2:7-diamino-carbazoles (290,733, XVIII, 580).

Inventions relating to the vat dyestuffs continue to be

very numerous, the great majority being concerned with the production of new dyes of the anthracene series or with improved methods of producing known dyes of this series. They include benzanthrone derivatives (298,931, XIX, 496 ; 296,490, XIX, 322 ; 293, 768, XIX, 243 ; 284,035, XVIII, 182 ; 280,846, XVIII, 85) ; dibenzanthrone (violanthrone) derivatives (295,506, XIX, 266 ; 294,672, XIX, 194 ; 294, 486, XIX, 297 ; 294,360, XIX, 173 ; 290,690, XVIII, 580 ; 288,666, XVIII, 462 ; 286,602, XVIII, 440 ; 284,656, XVIII, 327) ; isoviolanthrones (289,103, XVIII, 494 ; 288,666, XIX, 462) ; anthanthrones (297,234, XIX, 398 ; 295,600, XIX, 369 ; 288,291, XVIII, 535 ; 287,020, XVIII, 347 ; 286,669, XVIII, 463 ; 280, 217, XVIII, 35) ; pyranthrones (285,502, XVIII, 369 ; 282,913, XVIII, 103) ; some simpler condensation products from amino- and hydroxy- anthraquinones (292,897, XIX, 85) and some new esters of leuco compounds of vat dyes of the class of Indigosol and Soledon colours (295,716, XIX, 399 ; 288,673, XVIII, 462).

Purification of Gases

Some new methods have been published for the purification of gases, more particularly from sulphur compounds. Thus, hydrogen sulphide and hydrogen cyanide are removed from fuel gases (280,165, XVIII, 35 ; 286,633, XVIII, 440) by washing with a solution containing arsenic, antimony, tin, molybdenum, vanadium or tungsten, whose sulphides are soluble in alkali sulphide solution. The washing solution is obtained, for example, by passing hydrogen sulphide through sodium arsenite, and aerating the solution. The thio-arsenic compound can be used repeatedly after regeneration by oxidation. The amount of arsenic used is about 0·1—0·8 per cent. reckoned as trioxide. Silica gel impregnated with 1 per cent. of ferric or cupric oxide has been used (280,947, XVIII, 85) and also an aqueous solution containing ammonium sulphite and bisulphite. The latter extracts ammonia as well as hydrogen sulphide (285,999, XVIII, 304). Another invention employs alkaline potassium ferricyanide, which absorbs hydrogen sulphide with formation of sulphur and ferrocyanide. The latter is electrolysed to re-form the ferricyanide (289,885, XIX, 35). Active carbon has also been used for the removal of hydrogen sulphide (282,508, XVIII, 84), but the reaction is greatly affected by the humidity conditions and a humidity of 80 per cent. has been determined as the most favourable. Incidentally, carbon can be activated by su · hur vapour at 800°-1,000° C. (283,267, XVIII, 126), the properties of the carbon varying with the reaction conditions, and carbon disulphide is simultaneously formed.

Some Catalytic Reactions

The use of catalysts is now so widespread in the chemical industry that consideration of space forbids any adequate notice of the large number of inventions in this field. A few have already been referred to, and others which have been noted include several for the oxidation of sulphur dioxide. Thus, in one case (286,708, XVIII, 463) the catalyst is combined with a base exchange body—*e.g.*, silicates of two or more metals, one being a heavy metal, while in other cases (290,316, XVIII, 554, and 296,048, XIX, 400) the catalyst consists of a reactive zeolite which is the reaction product of a silicate and metallate, or silicate and metal salt in which there is combined in non-exchangeable form a catalytic component consisting of a metal or oxide of the 5th or 6th group. Such catalysts do not necessitate the purification of the gases which is so essential with platinum catalysts. In the vapour-phase oxidation of naphthalene to phthalic anhydride (282,559, XVIII, 102) an optimum temperature of 400°-450° C. is maintained by the use as a cooling agent of a mixture of lead 30 per cent., tin 30 per cent., mercury 40 per cent., which has a boiling point of 405° C., while in another invention relating to the same reaction (285,017, XVIII, 347) purification is effected by condensation and polymerisation of unsaturated components so that the impurities are converted into substances of much higher boiling point than phthalic anhydride.

Several inventions are for the catalytic treatment of alcohols to obtain various products. Thus, in 287,846 (XVIII, 516) ethyl alcohol is treated at 350° C. and 270 atmospheres pressure with a catalyst such as copper obtained by reduction in the presence of small quantities of manganese and magnesium oxides. About half of the alcohol is converted into ethyl acetate, normal butyl alcohol, and a little acetaldehyde.

Metallurgy

In the metallurgy of iron and steel, inventions appear to have been directed mainly to the reduction of ores without smelting, the use of gaseous reducing agents, chlorination extraction processes, and the improvement of cast iron. A new process for obtaining steel, or any desired steel alloy directly from titaniferous ores has been described.

Among a large number of new alloys are to be noted many aluminium alloys for various purposes, alloys for resisting corrosion by chemical agents and in which silver is the main constituent, and electromagnetic alloys.

Among the non-ferrous metals zinc and tin appear to have received most attention. Inventions relating to zinc include processes for its extraction from sulphide ores, processes of electrolytic extraction from solution, processes for its recovery from a zinc-oxide-lead sulphate fume, from spelter heap waste, and from solutions obtained by leaching ores. In the case of tin, processes have been described for the detinning of scrap, extraction from cassiterite ores, extraction by alloying with a collecting metal, extraction by means of sulphur, extraction from low grade ores, extraction from pyrite ores, separation from lead, and extraction by chloridisation.

Inventions relating to the metallurgy of copper include processes for its extraction from pyrites containing copper and zinc, for its recovery from iron pyrites, for its extraction by wet methods, for deoxidising it by means of beryllium, and for removing arsenic from cupriferous materials.

Processes for the extraction of platinum by treatment with hydrochloric acid in conjunction with chlorine, and by means of molten lead, and a process for the extraction of zirconium have been described.

Among recent patents of electrometallurgical interest are several for the electrolytic extraction of beryllium and aluminium, and for plating with chromium, and a process for obtaining pure antimony by electrolytic deposition from a solution of antimony trifluoride.

General

A few inventions involving the use of colloidal substances have been noted. An interesting case (293,504, XIX, 125) is that in which a colloidal suspension of iodine obtained by reaction between hydriodic acid and either hypoiodous or iodic acid in the presence of a protective colloid such as gum arabic is used as a disinfectant. The solution of iodine in water on which the disinfecting action depends is maintained notwithstanding removal of iodine by organic matter, and the product is more effective than an alcoholic solution of iodine. An invention (280,973, XVIII, 346) to obtain colloidal dispersions free from any undispersed solid matter has been noted, and also for obtaining dispersions (293,896, XIX, 144) by stirring the roughly ground material in a liquid with a large amount of another finely divided solid of greater hardness. This is applicable to the treatment of indigo, indanthrone, 1-amino-2-methyl-anthraquinone, pyranthrone, wood charcoal, etc., the added solid being iron, zinc, copper, silica, etc.

Several improvements in the production of white lead, titanium oxide, iron oxide, and other pigments have been noted, and also in distillation and rectification apparatus, in the concentration of alcohols and acids, particularly acetic acid from artificial silk processes, in the acid-proofing of chemical apparatus, and in the production of hydrogen peroxide.

Poison Gas Discovery in Cologne

A LARGE quantity of war-time gas recently discovered in a disused dynamite factory near Cologne has been identified as " Blue Cross " gas, which it is difficult to destroy with safety. It is considered too dangerous to be taken to sea. The Inter-Allied Commission was communicated with some time ago relative to its disposal, but, as no safe method of getting rid of the unwanted gas could be suggested, it was allowed to remain at the factory. Its interment in a deep underground chamber constructed of steel and concrete became necessary, as the city authorities intend to build houses for their officials in the neighbourhood.

Association of British Chemical Manufacturers

A Survey of its Activities and those of Related Bodies

This review, dealing with the activities of the most important association in connection with British chemical industry, indicates the varied and practical character of its work during the year, and emphasises the increasing need of such a central co-ordinating body of chemical manufacturers.

THE Association of British Chemical Manufacturers has continued to watch the general interests of the chemical industry during the past year along the usual lines.

There have been a considerable number of changes among its officers and its permanent staff. Dr. G. C. Clayton, M.P., was elected chairman of council in July in succession to Mr. C.A. Hill, who had completed the normal period of two years in that office. At the same time Lord Melchett and Dr. E. F. Armstrong were re-elected vice-chairman and treasurer respectively; Sir David Milne-Watson succeeded Sir Max Muspratt, Bart., as president, while Mr. C. A. Hill, the retiring chairman, was elected a vice-president.

Mr. W. J. U. Woolcock resigned his appointment as general manager and secretary early in the year, and Mr. J. Davidson Pratt, chief superintendent of the Chemical Warfare Research Department of the War Office, was appointed general manager in his stead. Shortly afterwards Miss Small, who had been a member of the staff for some six years, was appointed secretary, but this appointment she resigned in September. The Council then reverted to the previous arrangement by which the general manager was also secretary of the Association.

The membership of the Association has increased, due to the accession of a number of subsidiary companies of Imperial Chemical Industries, who have now become members.

The Association has throughout the year dealt with problems connected with legislation, tariffs, safety and health of workers, and transport, and with other matters affecting the general interests of the industry.

Legislation and Tariffs

The Association has kept a close watch on all new legislation, and has made representations, where necessary, to the Government departments concerned. The most important problem of this nature has arisen from the Budget Duty on hydrocarbon oils. Early representation succeeded in obtaining a concession in respect of fine essential oils, since the Association was able to show clearly that any attempt to enforce the duty on those oils would defeat its own object. An attempt was also made in conjunction with the Federation of British Industries to obtain a rebate of the duty on turpentine when used as a raw material for chemical manufacture—for example, for synthetic camphor and terpineol—but this was unsuccessful. At the present moment the new derating proposals are being closely watched.

The Association took an active part in 1927 in the Economic Conference at Geneva, and has recently supplemented the monograph which it then presented on the chemical industry by an addendum reviewing the position during the past year. The subject of tariffs is one in which the Association is much interested. In principle the Association welcomes any proposals which will facilitate trade, but at the same time it is unable to support the suggestion that this country should take the lead in removing all tariffs, since the industries protected are very few and are all of vital importance to the national safety. As far as chemical manufacture is concerned, the import restrictions in this country are limited to certain essential branches of the industry which it is necessary to protect in the early stages of development; to remove this protection without adequate safeguards against "dumping" might jeopardise these activities.

The case of calcium biphosphate under the Safeguarding of Industries Act of 1921, in which the Association was concerned, was one of considerable interest. This substance was excluded, among other compounds, from the dutiable list by the Board of Trade in the light of the decisions previously given by the referee. This exclusion was contested in the case of calcium biphosphate, and the new tribunal, on which were two scientific assessors, ruled that calcium biphosphate of baking powder quality was a fine chemical and had been improperly excluded. This was a decision of the greatest importance to chemical manufacturers in this country.

Welfare of Workers

During the year the Association has dealt with two important questions affecting the welfare of workers. At the suggestion of the Home Office, the Works Technical Committee of the Association is engaged in drawing up model safety regulations for chemical works, which it is intended shall be of general applicability and shall be carried out in principle in all factories, subject to such modifications of detail as are necessary in view of local circumstances. It is proposed that the regulations shall be accompanied by an explanatory brochure indicating the reasons for the regulations, the types of accident or illness which may arise from their non-observance, and the best and most convenient methods of putting them into operation. This work should prove of great value to the industry.

In conjunction with the Association of Tar Distillers, regulations have been drawn up with a view to safeguarding workers liable to pitch warts and their sequelæ. These proposals, which have been drafted in co-operation with the Home Office, have now been issued for adoption by all members concerned.

Constructional Materials for Chemical Plant

The Resistant Metals Committee of the Association, on which are represented the makers of resistant metals, the manufacturers of chemical plant, and the users of the plant, combines all the elements necessary for a concentrated and co-ordinated attack on the problems involved in finding the most suitable materials for use in the construction of chemical plant, in which there are serious dangers of corrosion with ordinary metals. The Committee has made useful progress during the year, but a large amount of work still remains to be done, necessitating the closest co-operation of all interests concerned.

Propaganda

The British Industries Fair serves as a useful means of spreading propaganda regarding British industries generally, and, in view of its comprehensive character, it receives the support of the Association in preference to any other exhibition. In 1928 there was an extensive and comprehensive exhibit of chemical products, which should have proved conclusively to anyone that the British chemical industry is now second to none in the range and quality of its products. Arrangements are now in train to ensure an exhibit of equal scope and interest in the 1929 Fair.

The Association has from time to time published a Directory of its members and their manufactures, which forms an invaluable buyers' guide to those interested in British chemical products. A thoroughly revised and up-to-date edition has been prepared and will appear in 1929. It will be given an extended distribution to likely buyers and inquirers all over the world.

The first experiment at collective advertising has just been made by the Association in the form of a composite advertisement for the fine chemical industry in the Industrial Chemical and Allied Industries number of *The Times* Trading and Engineering Supplement, published on November 24, 1928. It is hoped that the result will justify the experiment.

General

The Association has also co-operated in the standardisation work initiated by the Joint Fuel Committee. A special committee has been actively engaged during the year in standardising tests for all tar products as applied in regular works practice, and in the buying and selling of tar fractions. This work, which is now on the way to completion, will be of considerable value to all firms which either produce tar products or use them in their manufactures.

The Traffic Committee of the Association has been very active, and has done a large amount of valuable work on behalf of members by continually watching their interests in matters of transport and by obtaining from the railway

companies a large number of concessions in regard to traffic rates and regulations.

The Association also performs a large amount of more or less routine work in the shape of market reports, regular articles on the state of the industry, and the monthly issue to members of summarised information regarding trade at home and abroad, tariffs, etc.

As regards the future, the problems in hand or in sight are likely to keep the Association very fully occupied, and are of such a nature as to indicate that the need for the Association is still as great as it ever has been.

British Chemical Plant Manufacturers

THE British Chemical Plant Manufacturers' Association has had another useful year under the chairmanship of Mr. J. Arthur Reavell (of the Kestner Evaporator and Engineering Co., Ltd.), supported by Mr. W. Perry (Baker Perkins, Ltd.) as vice-chairman, and Mr. E. A. Alliott (Manlove, Alliott and Co., Ltd.) as treasurer. The secretaryship of the Association has changed owing to the resignation of Mr. W. J. U. Woolcock, and the new general manager of the Association of British Chemical Manufacturers (Mr. J. Davidson Pratt) has become the new secretary.

The Association has continued its advertising and propaganda campaign with satisfactory results, as evidenced by the increased number of inquiries from abroad. The scope of advertisement is now being widened, and at the same time a scheme is being formulated for supplying members regularly with information of interest from technical and other publications. The Directory showing the types of apparatus and plant manufactured by members, which was last issued in 1926, is being revised and improved. The new edition will be issued early in 1929, and will be given a very wide distribution at home and abroad.

The Association staged a collective chemical plant exhibit in the chemical section with very great success at the British Industries Fair in 1928. In the next fair there will not be an actual exhibit, as the policy is to participate every other year. The Association will, however, have an office in the Chemical Section, which will distribute the catalogues and other trade literature of its members and also serve as a meeting place.

As was mentioned in last year's review of the Association's activities, chemical plant of the most up-to-date and efficient type can now be obtained in this country, and it is gratifying to know that an important chemical undertaking in this country purchases practically all its plant from British makers.

There is still room, however, for a better understanding between chemical manufacturers and plant makers, and steps towards this end are now being taken. A most interesting and instructive discussion, initiated by Colonel G. P. Pollitt, took place on the subject "Is Anything Wrong With British Chemical Plant?" at the annual dinner of the Association in November, and indicated the lines along which a closer co-operation between plant users and makers might be achieved with great advantage to both. The Association will endeavour to see that the points which the discussion revealed are not neglected.

The Association has also participated in the important work of the Resistant Metals Committee, to which reference is made in the earlier notes on the Association of British Chemical Manufacturers. It has also become a member of the British Engineering Standards Association, and is giving continual attention to all problems of standardisation which are likely to be of benefit to the industry. The position is, therefore, satisfactory, and the Association may look forward with considerable confidence to increasing its sphere of usefulness to its members.

Association of Tar Distillers

This Association has been particularly active during the past year in collaboration with Group V of the Association of British Chemical Manufacturers, under the chairmanship first of Dr. T. Howard Butler (William Butler and Co.), and later of Dr. J. H. Roelofsen (Dorman, Long and Co., Ltd.). The active scheme for the collection of statistics, inaugurated at the beginning of 1927, has continued successfully throughout the year, and reliable data on the activities and progress of the industry have thereby been collected.

Through the Pitch Research Sub-Committee, members have continued their financial support of the work being carried on by the Department of Scientific and Industrial Research at the Fuel Research Station, East Greenwich. This work has particular reference to the use of pitch in briquette manufacture, and promises to give extremely valuable results.

Reference to the activities of the Association of Tar Distillers in connection with the drafting of the new regulations for the control of pitch warts has been made above when dealing with the Association of British Chemical Manufacturers.

The Association of Tar Distillers is represented on the Benzole Specifications Committee, originated by the National Benzole Association, on the appropriate sub-committee of the British Engineering Standards Association, and on the Standardisation of Tar Products Tests Committee.

British Disinfectant Manufacturers' Association

This Association has watched the interests of its members both at home and abroad. It continues to do so in an active manner, particularly in the direction of offering guidance in the effective use of disinfectants in the many directions in which preventive and corrective application is concerned.

Scottish Agricultural Industries

SCOTTISH AGRICULTURAL INDUSTRIES, LTD., was registered as a public company in Edinburgh on December 19, with a nominal capital of £1,750,000 in £1 shares. The objects are to acquire the whole or any portion of the shares, debentures, debenture stock and other interests of J. and J. Cunningham, Ltd., Alexander Cross and Sons, Ltd., Cross's Chemical Co., Ltd., John Miller and Co., Aberdeen, Ltd., Charles Tennant and Co., of Carnoustie, Ltd., and Daniel Wyllie and Co., Ltd., and to carry on the business of manufacturers and rectifiers of and dealers in sulphuric acid, superphosphate and artificial manures and fertilisers, dealers in sulphate of ammonia, tar distillers, dealers in grain, hay, oil cakes, feeding stuffs and agricultural products of all kinds, etc. The directors are :— J. C. Menzies, merchant; Sir Harry McGowan; H. J. Mitchell, director, Imperial Chemical Industries, Ltd.; J. G. Nicholson, director, Imperial Chemical Industries, Ltd.; Lt.-Col. George P. Pollitt; A. P. Cross, director, J. and J. Cunningham, Ltd.; A. Cross, director, Alexander Cross and Sons, Ltd.; T. Thornley, director, Alexander Cross and Sons, Ltd.; J. P. Miller, director, John Miller and Co. (Aberdeen), Ltd.; J. Wilson, director, Charles Tennant and Co., Ltd.; J. G. C. Wyllie, director, Daniel Wyllie and Co., Ltd. The secretary is H. W. Brown, 142, East Trinity Road, Leith, and the registered office, Council Chambers Building, Charlotte Street, Leith.

Japanese Fertiliser Production

THE following table shows the fertiliser production of the principal Japanese producing companies during 1927. The quantities are given in thousands of kwan (one thousand kwan equals approximately 4·133 short tons) :—

	Super-phosphate.	Mixed Fertiliser.
Nihon Sulphate Co.	1,868	441
Nitto Sulphate Fertiliser Co.	9,224	462
Niigata Sulphate Co.	5,187	457
Hokuriku Artificial Fertiliser Co.	4,093	388
Osaka Alkali Co.	8,072	680
Dai Nippon Artificial Fertiliser Co.	77,666	31,840
Formosan Fertiliser Co.	3,999	6,980
Rasa Phosphate Co.	24,370	629
Kami Shima Artificial Fertiliser Co.	10,896	880
Teikoku Artificial Fertiliser Co.	10,167	1,030
Sumitomo Fertiliser Co.	26,509	5,038
	182,051	48,825

For the period from January to June, 1928, inclusive, the same companies produced 117,330,000 kwan of superphosphate, and sales amounted to 160,195,000 kwan. Production of mixed fertiliser amounted to 37,252,000 kwan. It is reported that while fertiliser sales for the first six months of 1928 were good, prices were very low, and that it is the intention of the Japanese fertiliser association further to curtail production. The new quota will be 10 per cent. lower, which will make a total curtailment of 30 per cent. from the 1927 production.

Chemical and Allied Societies: Their work during the Year

The following notes on the work done during the year by the principal chemical and allied societies indicate the usefulness and variety of the functions covered by the various organisations.

British Association of Chemists

THE Association has made notable progress in the past year in almost all departments of its activity. The financial position is satisfactory and the surplus with every year's working continues to grow. It has now reached the total of £248, which leaves the Association in a more satisfactory position than it has occupied for many years. The Council does not wish to accumulate large reserves, but until a surplus equal to one year's income has been accumulated, every possible economy compatible with efficient working will be effected. The Unemployment Benefit Fund is also in a thoroughly sound condition and, if the present conditions are maintained, it may be possible in a year or two to increase the benefits.

The remarkable reduction in the unemployment returns of members of the Association is in large measure due to the increasing efficiency of the Appointments Bureau, since the facilities by which members requiring employment have been placed in direct touch with employers have been greatly extended. The salaries offered have on the whole been satisfactory and have justified the Council's policy and the hope of that policy in this direction. The Council has always looked unfavourably upon any policy which seemed to imply acceptance of the principle of the "flat rate." The result has been that where negotiation has been possible—and it has very frequently been possible—salaries very largely in excess of a so-called minimum salary have been obtained, and to the satisfaction of both parties.

The Legal Aid Department has completed another year's work without having had recourse to litigation, but this does not mean that its activities have decreased. On the contrary, the advice given upon agreements has more than doubled, and in all cases where members have applied for assistance in the matter of insufficient notice, a satisfactory settlement has been arrived at out of court.

Since the last review the *Chemical Practitioner* has been published bi-monthly and has attained its seventh issue with the October-November issue of this year. The circulation has included all universities and technical schools in Great Britain and abroad. Apart from its use to members, it has proved a valuable means of publicity.

The Association's campaign of publicity in connection with the registration of chemists has not only been intensified but has culminated in a provisional scheme for the formation of a General Chemical Council. The Council would wish opportunity of reasserting its opinion that this cannot and ought not to be the affair of any one society alone. It is already prepared to guarantee a sum of nearly £100 towards the expenses of a provisional council, and it will be ready, probably during the course of next year, to give effect to the policy already outlined in No. 7 of its official organ. The sum is small and is intended as nothing more than a guarantee of good faith, but the satisfactory response to the appeal indicates very clearly the trend of opinion within the Association.

The Association's campaign of propaganda has been intensified and has included during the past year many notices in the daily press all over the world. The Council fully appreciate the many difficulties in connection with this form of publicity, but remains convinced that with its many disadvantages its influence is for good. The increased interest shown by the public in the work of the chemist is in large measure due to the Association's activities in this direction. It is recognised as useless to expect really accurate information to be conveyed in this way. The aim has been rather to stimulate interest to a degree sufficient to encourage the public in an elementary study of the profession's work.

In general the Council view the Association's progress with considerable satisfaction and look forward with confidence to increased activities in the coming year.

H. T. F. R.

The Chemical Society

DURING the year 1928 the Chemical Society has held 15 ordinary scientific meetings, at which 61 papers were read and discussed, and has published up to the end of November 404 papers occupying 3,093 pages, as against 386 papers and 2,900 pages at the corresponding period in 1927. Thus the society continues to pursue with vigour the work for which it was founded in 1841, namely, "the discussion and publication of new discoveries, and the interchange of valuable information respecting them." The Abstracts "A" in Pure Chemistry for 1928 have been published in *British Chemical Abstracts* by the Bureau of Chemical Abstracts. The Society has published Volume XXIV of the Annual Reports on the Progress of Chemistry, and has also issued a volume containing the Faraday Lectures delivered before the Society since the foundation of the Lectureship in 1868.

In addition to the ordinary scientific meetings the Society has held three special lectures. The first of these was delivered on February 23 by Professor A. Fowler, whose subject was "Spectra and Atoms." On May 10 Sir James Walker delivered the "Arrhenius Memorial Lecture," and on November 29, the first of the Liversidge Lectures founded in accordance with the will of the late Professor Archibald Liversidge, of Sydney University, was delivered by Professor F. G. Donnan, who chose as his subject "Physical Chemistry in the Service of Biology."

The Council still experiences difficulty in awarding grants from the Research Fund Account for research work, owing to the fact that the sum applied for continues to exceed the amount available for distribution. During the year, 63 candidates applied for £749, and grants amounting to £618 have been awarded.

Fellows of the Society and members of those societies which contribute to the upkeep of the library continue to make greater use of the library. During 1927 attendances numbered 8,002, and the number of books borrowed 5,489, as against 7,692 and 5,353 respectively the previous year. The library now contains some 32,000 volumes.

The present officers of the Society are: President, J. F. Thorpe, C.B.E., D.Sc., F.R.S.; Treasurer, T. Slater Price, O.B.E., D.Sc., F.R.S.; Secretaries, C. S. Gibson, O.B.E., M.A., M.Sc., and T. S. Moore, M.A., B.Sc.; Foreign Secretary, F. G. Donnan, C.B.E., D.Sc., F.R.S.; Assistant Secretary, S. E. Carr, F.C.I.S.; Librarian, F. W. Clifford, F.L.A.; while Dr. Clarence Smith is the editor, Dr. A. D. Mitchell the assistant editor, and Miss Le Pla, B.Sc., the indexer. The Society's rooms are at Burlington House, Piccadilly, London, W.1.

S. E. C.

Colour Users' Association

THE past year has been a period of more settled conditions in the dyestuffs industry, and no doubt this has been due to some extent to the greater confidence engendered as a result of the consolidation of the dyeware manufacturing interests. The home production and price of dyewares remain a problem requiring close attention, and users will surely expect satisfactory results in this direction from the amalgamations which have taken place.

The two-times factor which is applied in determining applications for licences on price grounds has been in operation since September 1, 1927, giving the British dyemakers protection to the extent of 100 per cent. above pre-war prices. This represents an index figure of 200 compared with the Board of Trade wholesale prices index of 137·9—conclusive evidence that the price users are paying for the establishment of the industry.

The Dyestuffs (Import Regulation) Act expires in January, 1931, and as suggested in the Chairman's address to the Colour Users' Association at the annual meeting on June 29 last, it seems desirable for the makers and users to get together to discuss the situation that will arise on the expiry of the Act,

and recommend to the Government an agreed course of action. A further suggestion made at that meeting is being acted upon, as the Dyestuffs Industry Development Committee has set in progress the machinery for the preparation of a report on the operation of the Dyestuffs Act since its initiation. It is to be hoped that this report will be comprehensive and instructive, and that the fullest possible use will be made of it.

Much attention has been given to the question of applications for licences on price grounds, and some modification of the present procedure is long overdue. It is the practice of the Licensing Committee to require applicants for licences on price grounds to furnish particulars of the foreign supplier's quotation, which is then reported by the Dyestuffs Advisory Licensing Committee to the British makers, who are given an opportunity of meeting their competitor's price down to the two times pre-war price if they wish to do so. This procedure, it is suggested, is scarcely fair to the foreign maker, whose quotations are simply utilised as a means of forcing down the British prices with little or no chance of his obtaining any competitive business. The danger to users lies in the inference that the foreign makers will refuse to quote for products coming within this category, and the users will thus be deprived of all competition in this highly protected market. A solution of the difficulty seems a simple matter. It would be much more satisfactory if the foreign quotations were disclosed only to the chairman and neutral members of the Licensing Committee and that quotations from the British makers should also be furnished to the Committee, leaving that body to make the final decision as to the granting or withholding of the licence. Unless some such procedure as this is adopted, the users will continue to suffer from the absence of competitive quotations.

A feature of the Association's work during the year has been the regular monthly publication, for the use of members only, of a Chemical Price Bulletin, comparing the prices of British chemicals used in dyehouses with the prices of similar products on the Continent and in America, thus enabling members to keep a watchful eye on the price tendencies of their chemicals at home and abroad.

The views of the Association on the question of the prices of dyewares have been stated frequently, but they should not be lost sight of, and they will bear repetition :—

> (1) The colour users of this country must have access to the best quality and range of dyestuffs, and
> (2) must be on as favourable terms as regards prices as any of their world competitors, the prices being such as would not retard the sale of their productions in overseas markets.

The average colour user, perhaps, does not appreciate the vast amount of work that goes on behind the scenes, particularly in regard to licensing matters, as so much of the work is necessarily of such a confidential nature that it cannot be divulged. The Joint Technical Committee—a body of users and makers' representatives—continues to perform excellent service to the industry, and amongst its recent activities may be mentioned the standardisation of vat colour pastes. Much difficulty has arisen in the past with regard to the comparative strengths of foreign pre-war and current products and British equivalents, in connection with applications for licences on price grounds, particularly in relation to the more expensive vat colours. To the Joint Technical Committee has been allotted the task of arriving at agreed standards on which the Licensing Committee can base their decisions, and this work has been performed with general satisfaction to all concerned.

The Safeguarding of Industries Act was, of course, extended in 1926 for a further period of ten years, but a provision was inserted in the Finance Act, 1926, whereby articles included in the list as dutiable might be exempted by order of the Treasury if not manufactured in this country. Advantage has been taken of this provision to secure the exemption of oxalic acid, but as the exemption expires in December, 1928, a further application has been submitted, and the period of exemption from duty has been extended to December 31, 1929. Certain anomalies continue to be observed in the application of the duty—the case of formic acid being an outstanding example. This product, which is used in large quantities, is subject to the safeguarding duty, but the British output is not, at present, equal to the demand. The result is that foreign acid has to be imported to supply the deficiency, and owing to the duty of thirty-three and one-third per cent., the British user has to suffer in competition with continental users, whilst no benefit is accruing to the British maker.

Representations have been made in the proper quarter, however, and it is hoped this anomalous position will soon be remedied.

E. G.

The Faraday Society

THE Society has had a very successful year. The outstanding feature has been the publication of the *Transactions* in regular monthly numbers. Until 1925 there were only three issues at irregular periods each year, and for the next three years six or eight issues were brought out each year. The result of the more frequent publication has been to lead to a considerable increase in the interest of the scientific public, throughout the world, in the activities of the Society. The punctual and regular publication of the *Transactions* has also led to an increase in the number of papers of a high order of merit which have been submitted for publication; workers are undoubtedly influenced by the fact that the interval between receipt and publication of a paper has now been reduced to the low average figure of eight weeks.

A very successful general discussion on "Homogeneous Catalysis" was held in Cambridge in September, at which the attendance of overseas visitors constituted a record, there being no fewer than twelve, of whom three were Americans. The discussion proved of value in bringing together the conflicting schools of thought. The papers, together with the full report of the verbal and other contributions to the discussion, were published on December 1. There was published also during the year the report upon the important general discussion on "Cohesion and Related Problems," which was held in London in November, 1927.

The Society celebrated on November 9 its Silver Jubilee. This took the form of a luncheon, held at Jules' Restaurant, when most of the surviving past-presidents and many of the founders and later members met, together with representatives of the allied societies in Great Britain and of the more important physico-chemical societies in foreign countries. The proceedings were characterised by the informality usually associated with the meetings of the Society. The toasts were few and were introduced by witty speeches, which nevertheless bore splendid testimony to the esteem in which the Society is held.

Particular attention was directed to the success which the Society had achieved in promoting international good-fellowship amongst physical chemists. In fact, it might almost be said that the Society, like the prophets, is more honoured abroad than at home. There are signs that this reproach is being removed, but the Society looks for a considerable accretion of membership of British physical chemists. After the luncheon the members adjourned to the Royal Institution, where the first Memorial Lecture in honour of the late Mr. F. S. Spiers, the first secretary of the Society, was delivered by Sir Oliver Lodge (the senior living past-president), Sir Robert Hadfield, who had been president for seven years during and after the war, taking the chair. The members in large measure, with their foreign guests, also took part in the annual chemical dinner and dance during the evening.

On October 1 Professor T. Martin Lowry, who has almost since the inception of the Society been one of its most enthusiastic supporters, became president. He has the good wishes of all for a very useful term of office.

The Society looks forward in 1929 to a year of increased prosperity, with the greater support of British physical chemists.

G. S. W. M.

The Institute of Metals

DURING the past year the growth of the Institute of Metals has been so vigorous that the membership, for the first time, has topped the 2,000 mark—and this in the 20th year of the Institute's existence In view of the difficult trade conditions prevailing in this country, it is not surprising to find that the majority of the 200 new members elected during 1928 are resident abroad. The United States has provided the largest number of recruits from any one country, being followed by Germany, Japan, Australia, Russia, Spain, and Italy in the

order named. The strengthening of the international character of the Institute is very striking; now nearly one-third of the members reside abroad.

To cope with the increased membership the Council more than doubled the Institute's office accommodation early in the year, the new offices—including a fine library, reading room and council chamber—being formally opened at a "housewarming" given to the members in connection with the spring meeting.

At that meeting the new President, Dr. W. Rosenhain, F.R.S., of the National Physical Laboratory, took the chair for the first time; he will be in office for two years.

In May the Institute held its annual May lecture, which was given by Professor C. H. Desch, F.R.S., of Sheffield University, on the subject of "The Chemical Properties of Crystals."

At Liverpool, in September, a very successful autumn meeting was held. The 300 visiting members were received by the Lord Mayor; 15 papers were discussed and many works were visited.

The six local sections of the Institute continued to do excellent work in Birmingham, Glasgow, London, Newcastle-on-Tyne, Sheffield and Swansea.

Two issues of the Institute's Journal (vols. 39 and 40) appeared during the year and well maintained the high standard set by this invaluable publication.

The activities of the Council were concentrated, during the closing weeks of 1928, on preparing for the Institute's "Coming-of-Age" celebrations, which are to take place in March, 1929, and of which full particulars may be obtained on application to the Secretary, Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, Westminster, S.W.1.

The Institute of Chemistry

The Institute continues to pursue the objects for which it was founded more than fifty years ago, and to extend and develop them as occasions arise. One of its chief objects, as stated in the Royal Charter, is to provide the Government and the public with the means of recognising those who have been properly trained and proved to be competent to practise chemistry as a profession. The Charter gives the Institute definite authority to examine, to grant certificates of competency, and to register such persons. The Regulations are constantly under review, and are modified from time to time to meet changing conditions. Thus, the Council endeavours to make provision for all who have undoubtedly "made good" as chemists to obtain admission to the membership.

The register at present contains the names of approximately 5,600 Fellows and Associates, and thus it will be seen that the more complete organisation of the profession is making good progress, while the Council, consisting as it does of chemists engaged in all branches of work, is sympathetically concerned, and takes action, where necessary, in all matters affecting the interests of the profession generally. The Censors, who are charged with the duty of protecting the honour of the profession, find in practice that the number of complaints in which direct disciplinary action has to be taken is fortunately very small; through them the Institute is able to protect the interests of individual members, when their names have been used or their qualifications have been exploited without their consent.

During the year the Council has been instrumental in inducing firms engaged in the beet sugar industry to realise that the conditions affecting chemists employed in their factories were in several respects unsatisfactory, and these firms have considerably improved the conditions. Very few members of the Institute were concerned in this action, which was taken largely in the interests of younger men who are seeking experience, and of those who have not yet acquired the qualifications necessary for membership.

The Institute has on several occasions made representations to Government Departments and local authorities in connection with the terms offered for public appointments. In some cases, it has not yet been found possible to induce the authorities to understand to the full the responsible nature of the work which chemists are called upon to do. Experience has shown, however, that by losing no opportunity of making protests, when deemed necessary, the Institute can gradually improve the status of the profession.

In the early part of the year a questionnaire was issued to members regarding their salaries and emoluments. The response was rather disappointing, and, in view of the incomplete returns, it was not thought advisable to publish the statistics. It may be said, however, that, in general, the salaries offered to young chemists and graduates showed signs of improvement, while those earned by men approaching middle age were decidedly better than in 1921, when the returns to a similar questionnaire were tabulated and published.

The Benevolent Fund has received improved support, especially in respect to the number of annual subscriptions.

The Council has decided to devote the income from the bequest made by the late Sir Alexander Pedler, of which the value at the present time exceeds £5,000, to the foundation of a research Scholarship of £300 a year, for work which is needed in the public interest. In October, Mr. George Morrison Moir, A.I.C., was elected the first Pedler Research Scholar. Mr. Moir, a graduate of the University of New Zealand, is working at the National Institute for Research in Dairying, at Shinfield, Reading, on methods for the determination of casein, albumin, and globulin in milk.

The Meldola Medal for 1917 was awarded in March to Dr. Juda Hirsch Quastel, A.I.C., for biochemical work undertaken in the University of Cambridge.

The Sir Edward Frankland Medal and Prize for the best student's essay was awarded to Mr. Malcolm Gillies of the University of Glasgow.

The Streatfeild Memorial Lecture was delivered in November by Professor A. R. Ling, who took as his subject "Contributions to the History of Starch and its Transformation Products."

The Local Sections have continued to show great activity. Scientific papers which have been read at their meetings have been reported in the technical and general press, while those relating to matters of professional interest have been reported in the Journal and Proceedings of the Institute.

The Institution of Chemical Engineers

DURING 1928 the progress of the Institution of Chemical Engineers is shown in an increase in membership of 15 per cent. At the annual corporate meeting in March, Sir Alexander Gibb was unanimously re-elected president, Messrs. J. Arthur Reavell and W. A. S. Calder vice-presidents, and Professor J. W. Hinchley and Mr. F. H. Rogers respectively hon. secretary and hon. treasurer. The presidential address, delivered in March by Sir Alexander Gibb on "The Economics of Power as Applied to Chemical Engineering" aroused much interest and widespread comment. In connection with the annual meeting, members were pleased to welcome to London Dr. O. Spengler, Director of the Institut für Zucker-Industrie, who read a paper dealing with the treatment of beet sugar effluents.

The Associate-Membership examination of this year was modified in two respects:—(1) a longer period was allotted for the completion of the "Home" paper, and (2) one of the four papers worked in London was devoted entirely to the preparation of a simple working drawing. These modifications followed recommendations made after the 1927 examination.

The President's Reception, held on November 7, again attracted a large and distinguished gathering, some 400 members and friends being received by Sir Alexander and Lady Gibb at the New Princes' Galleries.

Public lectures delivered in 1928 included one in October on "Fluid jets and their practical applications" by Professor A. L. Mellanby, and one in November by Dr. Paul Klein, who discussed, for the first time in this country, the "Making of rubber goods of latex by electro-deposition" and illustrated his lecture by practical demonstrations of the process.

Activities for the junior members were started during the year, the inaugural meeting being held on November 23.

The two-day conference on "Drying" held in December, attracted large gatherings and aroused much interest. While it was obviously impossible to deal with the entire field of drying, nevertheless it is felt that the papers covered a very comprehensive range.

During the year a party from the Institution (with members of the Society of Chemical Industry) visited Eastern Canada

and the United States of America on a return visit to that paid by the American Institute of Chemical Engineers to this country in 1925. The tour, which has already been described in THE CHEMICAL AGE, was altogether successful, and has enhanced the already cordial relations existing between chemical engineers on both sides of the Atlantic.

J. W. H.

Institution of Petroleum Technologists

AT the annual general meeting of the Institution of Petroleum Technologists, held in March, 1928, Mr. Alfred C. Adams was unanimously re-elected president for a further session, and Dr. A. E. Dunstan was elected an additional vice-president. The report of the Council showed a satisfactory state of affairs.

At the general meetings of the Institution, papers dealing with various aspects of petroleum technology have been read and discussed and have been published in the Journal. The Journal has also contained a number of other papers on petroleum and allied subjects, together with abstracts of the more important articles appearing in the technical press.

The work of the Standardisation Committee on the revision of " Standard Methods of Testing Petroleum and Its Products " has continued during the year, and it is expected that the new edition of the book will appear early in 1929.

A new branch of the Institution has been founded in Trinidad, and the three overseas branches, Rumania, Persia and Trinidad, are all making excellent progress.

The Institution has been officially represented at the complimentary dinner to Colonel L. Pineau, Directeur de l'Office National des Combustible Liquides, Paris, at the eighth Congress de Chimie Industrielle, Strasbourg, at the Fuel Conference of the World Power Conference, London, and at the Second International Conference on Bituminous Coal, Pittsburg. The Institution also has representatives on various scientific and technical bodies.

Society of Dyers and Colourists

DURING the year, meetings and lectures, under the various sections of the Society, have been held in Bradford, Huddersfield, Manchester, London, Leicester, Nottingham and Glasgow, particulars of which are included in the January and November, 1928, Journals. No further award of the Research Medal of the Worshipful Company of Dyers, London, has been made, the matter being still under adjudication.

In connection with the " Colour Index " of the Society, the demand for this work still continues, and the Society has recently issued a " Supplement " which is now in circulation.

The Committee appointed to consider " Standardising the methods of testing the fastness of dyed materials " have appointed research workers and the work is progressing very favourably. The Society hopes shortly to be in a position to publish an interim report on this subject.

The Perkin Medal of the Society was awarded in March to Dr. R. E. Schmidt, for " Epoch making discoveries of anthraquinone derivatives and dyestuffs therefrom," and the Gold Medal of the Society was at the same time awarded to Mr. Ernest Hickson for " Exceptional Services rendered to the Society " as Chairman of the Colour Index Revision Committee, as President and Chairman of the Publication Committee, his services in the latter capacity having extended over a period of 30 years.

J. B. A.

Oil and Colour Chemists' Association

THE Association has again to report that steady progress has been made during the past year. The number of members has increased and progress has also been made in its publications and papers contributed. Dr. J. J. Fox, F.I.C., has succeeded Mr. C. A. Klein as President of the Association. The Research Association of British Paint, Colour and Varnish Manufacturers has been going steadily ahead. The Sub-Committee and Panels of the British Engineering Standards Association have published 56 specifications, and it is estimated that the programme will be completed on the publication of the sixtieth specification. The Manchester Section of the Association is now under the chairmanship of Mr. T. H. Bridge and is continuing to make steady progress. The annual general meeting of the Association held on May 10, 1928, was followed by a demonstration of various laboratory instruments. The President read his address on December 13, 1928, the subject being " Recent Analytical Methods."

The production of the section of the *Annual Reports on th, Progress of Applied Chemistry* (1927) dealing with paintse pigments, varnishes and resins has been undertaken by the following members of the Association: A. A. Drummond, J. Parrish and S. S. Woolf, under the editorship of the hon. editor of the Oil and Colour Chemists' Association. The members of the Association were enabled, through the courtesy of Mr. T. Wilson, Deputy-Keeper of Westminster Hall, to inspect the historical paintings at the Houses of Parliament. These paintings were of particular interest to the members who took advantage of the invitation, as they included examples of all the technical processes which have been used in the attempt to discover the most durable method of mural painting under modern conditions. On the social side, the Association held its annual dinner at the Hotel Cecil, London, which was followed on this occasion by a dance. On November 30, 1928, a social evening and dance was held at Ye Mecca Café, Ludgate Hill.

British Chemical and Dyestuffs Traders' Association

THE work of the Association during 1928 has been something of the nature of a record of service and benefit to the trading interests it represents. While the ordinary routine work has gone on as usual, some important matters affecting the merchants' interests have been dealt with. These relate to difficulties with H.M. Customs.

During the year the general bond system was introduced, enabling importers to clear goods immediately they are sampled and without waiting for the result of the " test." This new method saves anything from three to ten days or more of hitherto unavoidable delay at the docks.

Arrangements were also made whereby samples of key industry chemicals would be imported by foreign sample post. Hitherto the only method was by foreign parcels post.

The Association contested Customs authority for introducing Form C. 105, and after meeting the authorities, the demand for these certificates was withdrawn, so far as members were concerned. The Board of Trade have agreed to permit import of samples of dyestuffs without licence.

The membership continues good, and the Association is in consequence well able to speak and act with authority on behalf of the chemical merchants of the country. The Secretary (Mr. O. F. C. Bromfield) completes ten years of service with the end of this year.

Trona Process of Borax and Potash Production

THE Trona Process for manufacturing potash and borax by evaporation, followed by fractional crystallisation, is described in a beautifully produced booklet issued by the American Potash and Chemical Corporation, which has been distributed by their European agents, Clifford Christopherson and Co., Lloyd's Avenue, London. The process is based upon a knowledge of the effects of temperature and concentration upon the solubilities of the various salts in Searles Lake.

The brine coming from wells sunk into the main salt body is pumped about four miles to the plant, where it is mixed with various end liquors obtained in the operation of the process. The mixture is fed into triple effect evaporators. The flow of steam is counter to the flow of liquor so that the final evaporation is carried out at the highest temperature. During evaporation only the less valuable constituents of the liquor, consisting of sodium chloride, sulphate and carbonate crystallise out and are removed and returned to the lake. Evaporation is continued nearly to the point where potassium chloride would begin to crystallise out. The hot concentrated liquor is then cooled to the requisite temperature to effect the crystallisation of a large portion of the potassium chloride. The crystalline potassium chloride is rapidly removed from the bulk of the liquor by means of continuous settling tanks. The mother liquor is carbonated and further cooled to bring about the crystallisation of the larger portion of the borax. The products of the Trona process are sold under the names of Three Elephant Borax, Three Elephant Boracic Acid, and Trona Potash Salts.

From Week to Week

TRANSPARENT PAPER, LTD., has acquired a process for the manufacture of sheet cellulose acetate.

AN AMERICAN newspaper has been printed on paper stated to have been made from cornstalks.

INDIAN INDIGO EXPORTS in October amounted to 79 cwts., compared with 68 cwts. in October of 1927.

THE VOLUME OF IMPORTS of chemicals into Italy in the first nine months of this year was 1,186,724 metric tons, while exports from the country were 174,303 metric tons.

THE FINNISH STATE WORKS produced, in 1927, 10,456 tons of 93 per cent. sulphuric acid, and 19,722 tons of superphosphate, for the production of which most of the acid was used.

A SIX AND A HALF MILLION DOLLAR (£1,300,000) insurance scheme has been approved by the directors of the Eastman Kodak Co., of Rochester, N.Y., for their 20,000 employees at home and abroad.

AN IMPORTANT MEETING will be held on December 31 with a view to the formation of a Belgian cartel to deal with fertilisers. It is proposed that the cartel should have a capital of 75,000,000 francs (£428,000).

MR. W. V. BLEWETT, formerly works manager of the Nobel Explosives chemical works at Durban, has joined the staff of Nobels Australia, Ltd., and is investigating the fertiliser situation in Australia.

SIR MAX MUSPRATT, on Friday, December 21, was elected chairman of the Parliamentary Committee of the Liverpool City Council, in place of the late Sir Archibald Salvidge. Sir Max is already chairman of the Finance Committee.

MR. H. G. POOLE, M.Sc., of Melbourne University, has been appointed assistant chemist of the Waite Institute, Glen Osmond, Adelaide. His duties will be mainly in connection with soil investigation in the River Murray irrigation area.

STEPS ARE BEING TAKEN by the Australian and General Asbestos Co., Ltd., to develop an extensive deposit of asbestos existing at Sherlock, West Pilbarra, Western Australia, 20 miles from the port of Balla Balla. The product is said to be of high quality.

BEET SUGAR NEWS.—With regard to river pollution, the Trent Fishery Board announces that the Colwick and Kelham beet sugar factories are still causing pollution, and at a meeting of the board Sir Albert Ball said that in view of the fact that it was possible to stop it, it looked as if the time had come to take action at these two places.

AGREEMENTS have been arrived at among European cement producers under which Belgian, German and Dutch cement manufacturers will share the Dutch market; while German and British producers have agreed not to compete in each other's markets. France will be given a quota for export to Germany.

ARTIFICIAL SILK NEWS.—The I.G. is engaged in extending its artificial silk interests. Negotiations are pending with Enka. It is not known whether this indicates a further approach to the Vereinigten Glanzstoff-Fabriken or an attempt on the part of I.G. to strengthen itself against the latter.—Representatives of Courtaulds, Ltd., are awaited in Warsaw to arrange work in connection with the erection of an artificial silk factory in Poland.

THOMAS W. WARD, LTD., of Sheffield, have acquired the whole of the vast undertaking of the Lowmoor Ironworks, comprising the blast furnaces, coke and by-products plant, foundry, forge, and rolling mills, engineering and macadam works. The purchase includes the extensive estate with collieries, mineral bearing lands, farms, houses, etc., and the whole of the assets of the Best Yorkshire Iron Co., Ltd. Iron has been worked at Lowmoor for several centuries.

A COMPANY with a capital of £100,000 to develop what is known as the paint "mine" at Bideford has been formed. "Bideford black," obtained from this mine, is a form of carbon which has use in rubber compounding and has been worked intermittently for years. The local syndicate which was investigating the possibilities of the material has sold its interest, the purchasers, it is believed being the South Wales anthracite trust, with which Lord Melchett is associated. Plant capable of producing 8,000 tons a year of Bideford black is being installed and will be working in six months.

THE AMERICAN CHEMICAL SOCIETY'S annual summary of the outstanding achievements in 1928 cites the development of synthetic sodium nitrate by the plant at Hopewell, Virginia; the production of motor fuels from coal by direct hydrogenation in Germany; and also the investigation of lead tetraethyl as among the achievements whereby the world made a conspicuous advance in chemistry. The synthetic rubber problem, although advanced and somewhat nearer completion, is still far from being a commercial success; while the Dead Sea salts project remains "in very much the same status at the beginning of 1929 as it occupied at the beginning of 1928."

FATAL INDUSTRIAL ACCIDENTS in November included three in chemicals factories.

THE CAPITAL of the British Cement Products and Finance Co. is to be increased to £1,000,000.

FROM NOW ONWARDS Courtaulds, Ltd., will refer to their artificial silk products as rayon, and not artificial silk.

RECENT WILLS INCLUDE: Mr. A. Clarke, analytical chemist with George Bassett and Co., Ltd., confectionary manufacturers, £5,479 (net personalty, £5,321).

DR. C. DREYFUS announces that Mr. Theodore T. Merseles, president of the John Manville Co., has been elected a director of the Celanese Corporation of America.

DRUGS, CHEMICALS AND PERFUMERY imported into Rhodesia in the first eight months of 1928 were valued at £187,000. Re-exports of these products were valued at £27,000.

THE CENTENARY of the death of William Hyde Wollaston occurred on Saturday, December 22. He discovered the elements palladium and rhodium as the result of analyses of platina residues.

SIR E. A. BROTHERTON entertained his tenants and friends of the Kirton, Firby, Whitwell and Foston estates to a concert and dance in Whitwell Village Hall Institute on Friday, December 21.

DORMAN, LONG AND CO., LTD., of Middlesbrough, have secured a contract to build a new bridge over the Thames to replace that crossing the river immediately outside Imperial Chemical House.

MR. J. AVERY, now in the research department of the British Dyestuffs Corporation, Ltd., Huddersfield, has received the degree of Ph.D. for research work done at the University of Birmingham.

CHILEAN NITRATE OF SODA DISTRIBUTORS is the name adopted by an organisation resulting from the fusion of two Hamburg importers of nitrate, Nordische Salpeter G.m.b.H. Gumprecht and Co., and Hugo Wiertz.

WHOLESALE PRICES in currency of chemicals in certain foreign countries in October were as follows: Germany (1913=100) 127·3; Belgium (1914=100) 716; Italy (1913=100) 370·5; United States (1926=100: prices in gold) 95·6.

THE DIRECTORS of the British Feeding-Meals Manufacturing Co. state, with reference to the new fish meal plant at Stratford, that the guarantees as to capacity given by the maker have been exceeded. Fuel consumption has been reduced by 60 per cent.

TWO WORKMEN, one of whom died, were overcome by fumes while engaged in lining tanks with rubber in the glycerin department of Lever Brothers' works at Port Sunlight, on Friday, December 21. The tank in which operations were in progress was about 10 feet square, and a solution of benzine and rubber is stated to have been used.

IN CONNECTION with the proposed fusion of interests between the International Nickel Co. of Canada, Ltd., and the Mond Nickel Co., Ltd., it is announced that Mr. Emile Mond has resigned from his position as deputy-chairman of the Mond Nickel Co., but, at the request of his colleagues, has agreed to retain his seat on the board of that company.

A CENTRAL DEPOT for the examination of milk and the establishment of an average quality was advocated by Mr. H. T. Cranfield (advisory chemist, Loughborough) at a meeting of the Poulton branch of the National Farmers' Union on Monday, December 17. The public, he said, paid a more or less uniform price for milk and was entitled to a more or less uniform product.

SOME CONCLUSIONS reached after three years' research on the discolouration of cheese were described by Professor Leitch, of the West of Scotland Institute of Agriculture, on December 20, at Castle Douglas. He was able to say that the agent was biological, although in their present state of knowledge they could not say what organism caused the discolouration. Pasteurisation of milk would delay or prevent the discolouration.

DR. C. KRAUCH, at the second International Conference on Bituminous Coal, held recently at Pittsburgh, described the results obtained by the I.G. on the hydrogenation of solid fuel. At Leuna the annual output of synthetic motor spirit would by the end of 1929 have reached 250,000 tons. Hydrogenation had proved to be a means of desulphurising mineral oil, and by arrangement with the Standard Oil Co. this was to be introduced into American refinery practice. At some future date such a process might be of decisive importance in refining oil from English shales rich in sulphur. Dr. Krauch advanced a new theory that petroleum resulted from the hydrogenation of vegetable remains.

Obituary

DR. ANDREW M'MILLIAN, lecturer in analytical chemistry at Glasgow University, on Wednesday, December 19.

DIRECTOR FRITZ KUCHLER, of the I.G. Farbenindustrie A.-G., on December 13. He was formerly connected with the Chemischen Fabriken vorm. Weiler-ter Meer.

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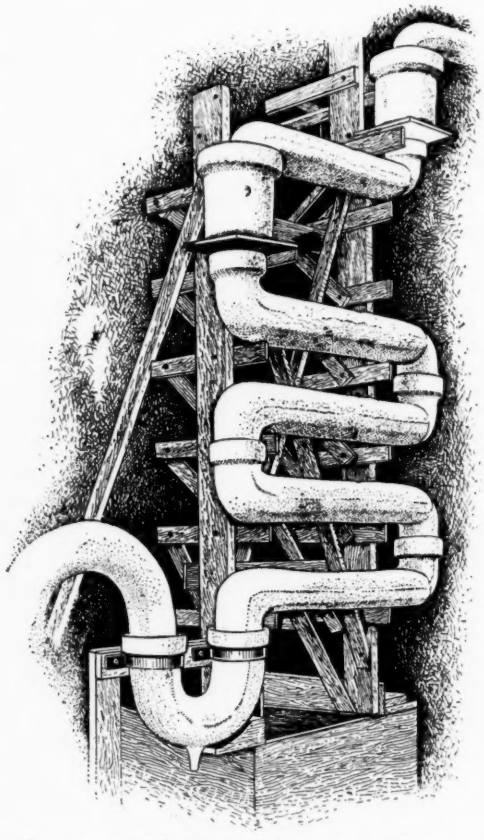

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Patent Literature

The following information is prepared from published Patent Specifications and from the Illustrated Official Journal (Patents) by permission of the Controller to H.M. Stationery Office. Printed copies of full Patent Specifications accepted may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, at 1s. each.

Abstracts of Complete Specifications

300,940. *o*- AND *p*-XYLENES, MANUFACTURE OF. A Carpmael, London. From I.G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany. Application date, August 20, 1927.

Toluene is treated with formaldehyde or substances yielding it in the presence of hydrochloric acid and a condensing agent such as chloride of zinc, tin, aluminium or iron. A good yield is obtained of *o*- and *p*- xylyl chlorides, and these are converted into the corresponding *o*- and *p*-xylenes by chemical, electrolytic, or catalytic reduction with hydrogen. The separation and purification of the *o*- and *p*-xylenes can be effected by fractional distillation or by sulphonation, since *o*-xylene is much more readily sulphonated than *p*-xylene. These sulphonic acids are then hydrolysed. Examples are given.

301,000. ALCOHOLS, MANUFACTURE OF. J. Y. Johnson, London. From I.G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany. Application date, June 18, 1927.

The products of destructive hydrogenation of mineral oils, coal, or their extraction, distillation, or conversion products, are subjected to a preliminary dehydrogenation, splitting, or cracking treatment and are then converted into alcohols by adding on water to the double bonds. This is effected by adding sulphuric acid, and then hydrolysing the resulting compound. An example is given of the treatment of the gas mixture obtained in the destructive hydrogenation of coal, to obtain isopropyl alcohol and butyl alcohol.

301,009. HALOGENATED HYDROCARBON PRODUCTS AND ANALOGOUS SUBSTANCES, PRODUCTION OF. J. Y. Johnson, London. From I.G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany. Application date, June 18, 1927.

Products obtained by the destructive hydrogenation of mineral oils, coal, or their extraction, distillation, or conversion products are converted into halogenated hydrocarbons, *i.e.*, halogen hydrins, nitriles or isonitriles, or halogenated acid chlorides by adding on halogen, hydrogen halides, hypohalogenous acids, hydrocyanic acid, or phosgene, to the double bonds. Treatment with halogens may be effected in the presence of catalysts such as active charcoal, antimony pentachloride, or ferric chloride, and substances capable of transferring halogen such as phosphorus or iodine may be employed. High temperatures such as 400°—500° C. may be employed, in which case the catalyst may be iron oxide, aluminium or anhydrous aluminium chloride. The products of destructive hydrogenation may be subjected to a preliminary dehydrogenation, splitting, or cracking treatment.

301,130. RECOVERY OF OILS OF HIGH BOILING POINT FROM THE RESIDUES OF MINERAL OILS, TAR OILS, ETC. J. Y. Johnson, London. From I.G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany. Application date, September 5, 1927.

The losses which occur in the distillation of liquid or solid residues of mineral oils, tar oils, destructive hydrogenation products, etc., are avoided by introducing into them at temperatures above 300° C., and at reduced pressures, gases or vapours which contain lower boiling liquids such as water, benzene, toluene, alcohol, benzine, preferably in the state of mist. A current of gas containing mist may be obtained by cooling the mixture of gas and vapour so that part of the vapour condenses to a fine mist. Examples are given of the treatment of the crude oil residue and a distillation residue of the destructive hydrogenation product of lignite, these viscous products being distilled without loss.

301,175. AZO DYESTUFFS, MANUFACTURE OF. O. Y. Imray, London. From I.G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany. Application date, October 28, 1927.

These azo dyestuffs are obtained by the combination of aromatic diazo compounds with 2:6-naphthol-carboxylic acid. Examples are given of the combination of 2:6-naphthol-carboxylic acid with diazotised aniline, parachloraniline-ortho-sulphonic acid, paranitro-ortho-amino-phenol, and ortho-nitro-ortho-aminophenol-parasulphonic acid. The products are red to brown powders soluble in concentrated sulphuric acid to a reddish solution. Wool is dyed red to brown, turning blue to black on after-chroming.

301,193. TRIARYL METHANE DYES, PROCESS FOR PREPARING. British Dyestuffs Corporation, Ltd., Hexagon House, Blackley, Manchester, F. W. Linch, and E. H. Rodd, Crumpsall Vale Chemical Works, Blackley, Manchester. Application date, November 17, 1927.

Specification No. 272,321 (See THE CHEMICAL AGE, Vol. XVII, p. 85) describes the production of carbinols of the triaryl-methane series by condensing sodium derivatives of tetra-alkyl-diamino-benzophenones with aromatic chloro compounds at 85°—100° C., using toluene as a solvent, but under these conditions, by-products such as diaryl-benzyl-carbinols are also formed. It is now found that the condensation proceeds equally well at 60° C., employing benzene as a solvent, and a smaller quantity of by-products is formed. An example is given of the condensation of Michler's ketone with 4-chloro-*m*-xylene, and other chloro compounds can be treated in a similar manner.

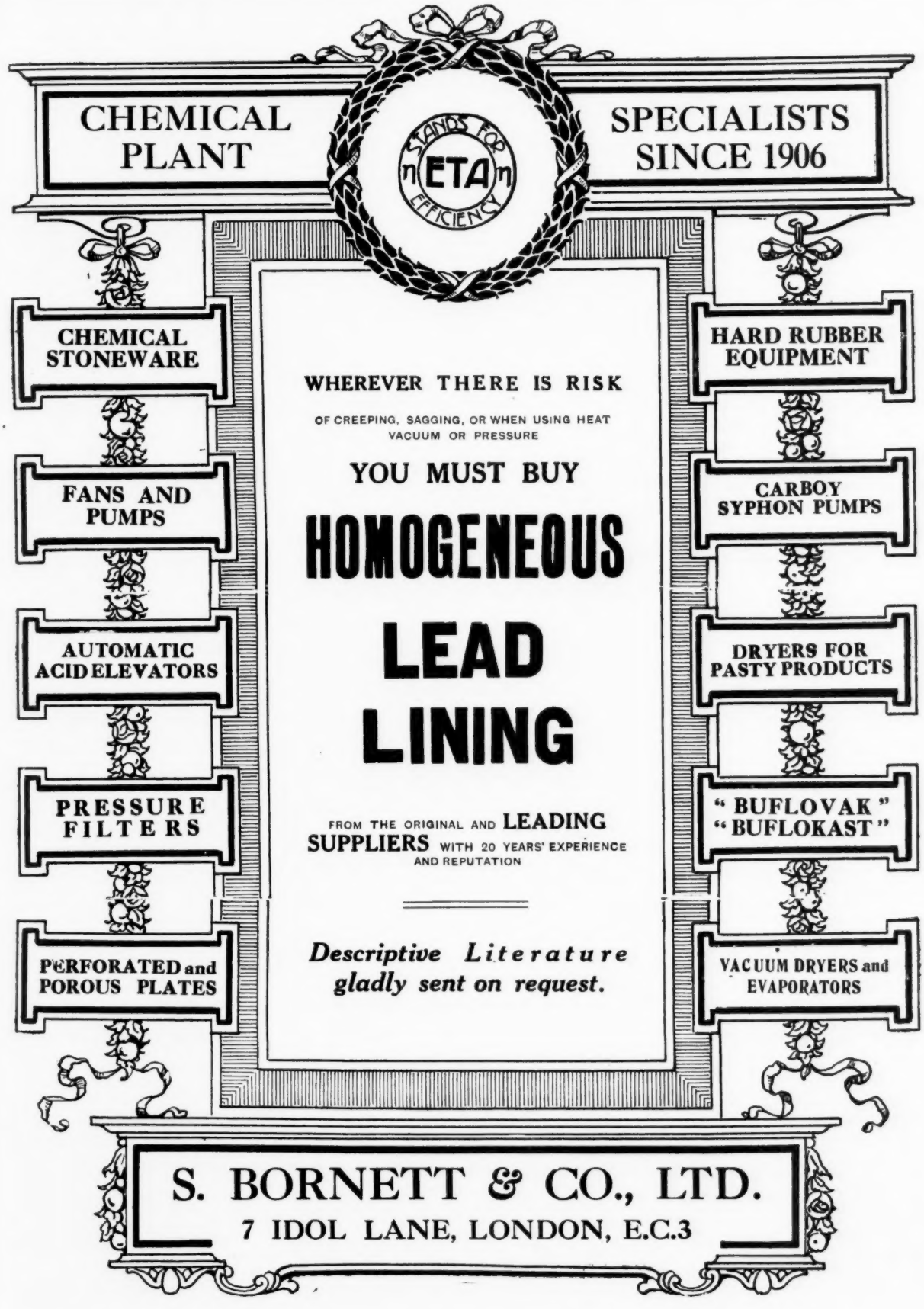
301,197. VAT DYESTUFFS, MANUFACTURE OF. J. Y. Johnson, London. From I.G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany. Application date, November 21, 1927. Addition to 289,980.

Specification No. 289,980 (See THE CHEMICAL AGE, Vol. XVIII, p. 554), describes the production of vat dyestuffs by fusing a Bz2-amino-benzanthrone with caustic alkali under mild conditions. This treatment may now be applied to other amino benzanthrones in which the amino group is situated in that benzene nucleus of the fundamental anthraquinone, which is not linked with the engrafted benzene nucleus, *i.e.*, the 5-, 6-, 7-, or 8-amino benzanthrones. Different dyestuffs are obtained according to the conditions of working, *e.g.*, by employing an alcoholic caustic alkali melt, or by varying the temperature of proportion of the reacting substances. Examples are given of the treatment of these amino-benzanthrones by fusing with caustic alkali, and the dyestuffs obtained are described.

301,210. TREATING CALCIUM COMPOUNDS WITH SULPHURIC ACID OR ITS SALTS. J. Y. Johnson, London. From I.G. Farbenindustrie Akt.-Ges, Frankfort-on-Main, Germany. Application dates, December 5, 1927 and March 19, 1928.

In the treatment of calcium compounds with sulphuric acid or sulphates, the gypsum obtained may be in a mucilageous form, which is difficult to separate from the liquid. In this invention, the gypsum is obtained in a granular form by adding to the reaction mixture small amounts of metaphosphoric acid, or its salts which are soluble in the reaction mixture. The amount of metaphosphoric acid necessary varies from 0·3 per cent. to 10 per cent., according to the materials treated. The mother liquor can be employed as the source of metaphosphoric acid after removal of precipitated calcium sulphate. The process is applicable to the double decomposition between calcium sulphate and calcium nitrate to obtain potassium nitrate, or to the treatment of phosphate rock with sulphuric acid or acid salts to obtain phosphoric acid or its acid salts. Examples are given.

NOTE.—Abstracts of the following specifications which are now accepted, appeared in THE CHEMICAL AGE when they became open to inspection under the International Convention—275,670 (I.G. Farbenindustrie Akt.- Ges.) relating to obtaining hydrocarbons by destructive hydrogenation, see Vol. XVII, p. 352; 276,692 (I.G. Farbenindustrie Akt.-Ges.) relating to monobenzoyldiamino-anthraquinones, see Vol. XVII, p. 445; 279,884 (Schering Kahlbaum Akt.-Ges.) relating to higher alkylated guanidine derivatives, see Vol. XVIII, p. 35;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282,011 (Naugatuck Chemical Co.) relating to treatment of rubber latex, see Vol. XVIII, p. 150; 282,375 (I.G. Farbenindustrie Akt.-Ges.) relating to alkyl pyrazolanthrones, see Vol. XVIII, p. 183; 284,678 (P. L. Hulin) relating to electrolytic production of light metals, see Vol. XVIII, p. 39 (Metallurgical Section); 286,282 (N. Caro and A. R. Frank) relating to alkaline nitrogenous fertilisers, see Vol. XVIII, p. 440; 286,708 (Selden Co.) relating to the contact sulphuric acid process, see Vol. XVIII, p. 463; 293,438 (R. Ludecke) relating to trimethylamine glycol monoborate, see Vol. XIX, p. 243; 293,361 (Gasverarbeitungsges.) relating to drying gases for ammonia synthesis, see Vol. XIX, p. 219; 295,587 (I.G. Farbenindustrie Akt.-Ges.) relating to destructive hydrogenation of carbonaceous materials, see Vol. XIX, p. 369; 296,373 (I.G. Farbenindustrie Akt.-Ges.) relating to vat dyestuffs of the anthanthrone series, see Vol. XIX, p. 441; 296,782 (Schering Kahlbaum Akt.-Ges.) relating to isothiourea ethers, see Vol. XIX, p. 466.

International Specifications not yet Accepted

299,064. DIMETHYL, METHYLENE AND CHLORMETHYL SULPHATES; CHLORMETHYL SULPHATE CHLORIDE; DICHLORDIMETHYL ETHER. K. Fuchs, 78, Schottenfeldgasse Vienna, and E. Katscher, 18, Meytensgasse, Vienna. International Convention date, October 21, 1927.

Formaldehyde and its polymers are treated with halogen sulphonic acid, or its salts, esters, or components. The same treatment may be applied to "functional derivatives" of formaldehyde—*i.e.*, substances containing CH_2 not directly combined with carbon, such as methylene ether, dichlordimethyl ether, methylene esters, and Schiff's bases of formaldehyde. Several examples are given of the treatment of paraformaldehyde with chlorsulphonic acid under various conditions, and also the treatment of dichlor-dimethyl sulphate, methylene sulphate, dichlor-dimethyl ether, and methylene chloride with chlorsulphonic acid.

299,302. PURIFYING GAS. C. J. Hansen, 33, Trappenbergstrasse, Essen, Germany. (Assignee of H. Koppers Akt.-Ges., 948, Postfach, Essen, Germany.) International Convention date, October 22, 1927.

Ammonia and sulphuretted hydrogen are removed from gases by scrubbing with a solution of iron and oxy compounds of sulphur. The liquor is regenerated by adding sulphurous acid.

299,306. LEAD PEROXIDE. Siemens and Halske Akt.-Ges., Siemensstadt, Berlin. International Convention date, October 22, 1927.

An alkaline solution of a lead salt is electrolysed to obtain lead peroxide, an organic compound of one of the following classes being added to the liquid: (1) hydrocarbon compounds containing oxy groups, *e.g.*, phenol, resorcin, hydroquinone, pyrogallol, tannin, phloroglucine, glycerine, sugar or fluorescein; (2) organic acids without oxy groups such as acetic acid or succinic acid; (3) carbon-nitrogen compounds such as dimethyl-glyoxime, alizarine-bordeaux, rhodanide, and cyanides.

299,319. CHLORACETALDEHYDE. I.G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany. International Convention date, October 22, 1927.

Chlorine gas and vinyl chloride are introduced into water, without a catalyst, at 0–40° C. to obtain chloracetaldehyde. A neutral gas is preferably added also, to assist in mixing, and light should be excluded.

299,327. DYESTUFF INTERMEDIATES. I.G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany. International Convention date, October 22, 1927.

Primary aromatic amines having a free para position are treated to obtain halogen aryl-thioglycollic acids by introducing a sulphocyano group into this position by treating with an inorganic sulphocyanate and a halogen, saponifying the sulphocyano group to form a mercapto group, converting the latter by condensation with chloracetic acid into a thioglycollic acid group, and replacing the amino group by halogen by Sandmeyer's reaction. Examples are given of the treatment of *m*-toluidine, 1-methyl-2-amino-4-chlorbenzene, and *p*-xylidine.

299,330. ACETONE. Consortium für Electrochemische Industrie Ges., 20, Zielstattstrasse, Munich, Germany. International Convention date, October 22, 1927.

Acetone is obtained by passing acetic acid vapour over a heated catalyst in apparatus of copper, ferrosilicon, or steels rich in chromium and nickel, at 400°–550° C.

299,331. DYES. Soc. of Chemical Industry in Basle, Switzerland. International Convention date, October 22, 1927.

Azo dyes and intermediates containing at least one cyanuric ring and at least one thiazole ring are obtained by condensing a cyanuric halide with compounds at least one of which contains a thiazole, or by coupling a diazo component with a coupling component so selected that one contains at least one cyanuric ring and the other at least one thiazole ring. A large number of examples are given.

299,332. DYES. I.G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany. International Convention date, October 21, 1927.

Azo dyes are obtained by coupling a diazotized 2:3-aminonaphthoic ester or a substitution product with a naphthol or with an arylide of 2:3-oxynaphthoic acid or a substitution product.

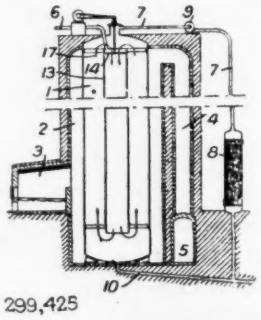
299,373. HYDROGENATING POLYHYDROXY COMPOUNDS. I.G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany. International Convention date, October 24, 1927.

The process is for treating sugars, starch, cellulose, glycerin, glucosans, polyhydroxy acids, and cyclic substances. The hydrogenation is effected at a pressure of 70–100 atmospheres and temperature of 190-300° C. in the presence of catalysts of the iron and platinum groups, copper, silver, gold or tungstic acid. Examples are given of the production of dihydroxypropane from glycerin, and of the treatment of dextrose, sugar, cellulose, etc.

299,419. PURIFYING AROMATIC COMPOUNDS. Selden Co., McCartney Street, Pittsburg, U.S.A. (Assignees of A. O. Jaeger, 9, North Grandview Avenue, Crafton, Pa., U.S.A.) International Convention date, Octover 26, 1927.

Hydrocarbons such as anthracene, naphthalene, and benzene-containing light oils are purified by partly oxidising the vapour with a limited quantity of oxygen in the presence of catalysts, to destroy the impurities. A very large number of catalysts is described.

299,425. HYDROCARBONS. J. Ylla-Conte, 49, Ronda San Antonio, Barcelona, Spain. International Convention date, October 26, 1927.



299,425

The apparatus is for producing benzene by condensation of acetylene. The reaction vessel 1 is heated by flues 2, 4, 5, receiving hot gases from a furnace 3. Acetylene is supplied at 6 and circulates through the vessel 1 to the outlet 7, leading to a condenser 8. The residual gas passes back through a pipe 10. The acetylene is circulated through the vessel 1 by a fan 14.

299,445. ALKALI IODATES. I.G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany. International Convention date, October 28, 1927. Addition to 290,749.

Specification 290,749 (See THE CHEMICAL AGE, Vol. XVIII, p. 580) describes the production of alkali iodates by treating alkali iodides with oxygen in the presence of an alkali hydroxide. In this invention, an oxide or hydroxide of an earth

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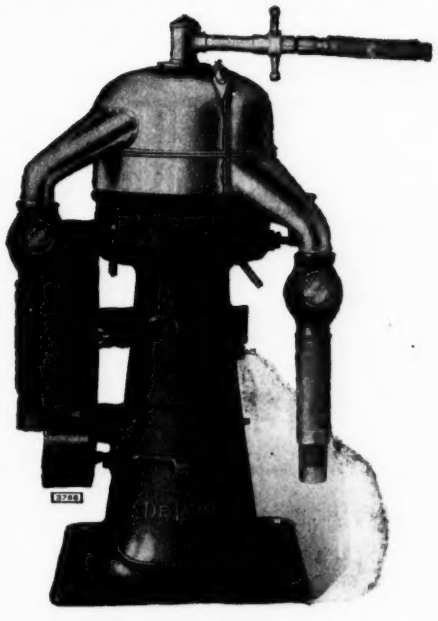

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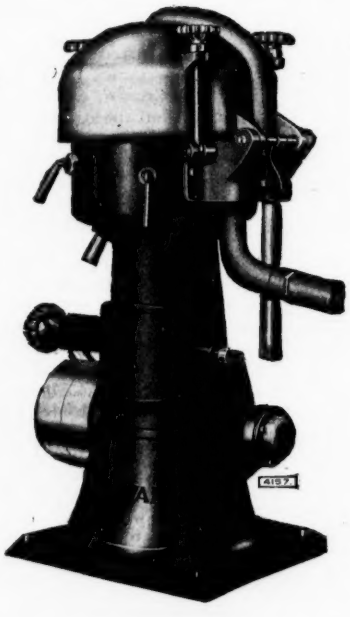
Below is shown a totally enclosed 1,000 gallon per hour Clarifier fitted with ball bearings and with gas-tight cover, suitable for handling extremely volatile liquids.



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metal or heavy metal may also be added, *e.g.*, bismuth oxide. The iodate may be decomposed again to obtain oxygen.

299,473. DYES. I.G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany. International Convention date, October 28, 1927.

Leuco compounds of the triarylemethane series are dissolved in pyridine or quinoline, and oxidised in the presence of a copper salt, and with water or an alcohol as a diluent. Some examples are given.

Specifications Accepted with Date of Application

288,214. Dyestuffs, Manufacture of. I.G. Farbenindustrie Akt.-Ges. April 4, 1927.

288,266. Copper- and zinc-containing ores, Process for working up. Metallbank und Metallurgische Ges. Akt.-Ges. April 7, 1927.

288,549. Carboxylis acid anhydrides, Manufacture of. Consortium für Electrochemische Industrie Ges. April 11, 1927.

297,096. Obtaining iron from ores. Vereinigte Stahlwerke Akt.-Ges. September 16, 1927.

300,164. Purification of metals. British Maxium, Ltd., November 7, 1927.

301,553. Tin or arsenic from ores and the like, Extraction of. H. L. Sulman and H. F. K. Picard. June 13, 1927.

301,764. Carbonic acid, Process and device for fully utilising. H. Dehottay. August 30, 1927.

301,769. Dyestuffs, Production of. L. J. Hooley, J. Thomas, and Scottish Dyes, Ltd. June 1, 1927.

301,772. Azo-dyestuffs containing chromium, Manufacture of. O. Y. Imray. (*Soc. of Chemical Industry in Basle.*) August 4, 1927.

301,775. Gases rich in olefines, Production of—from bituminous coals, and apparatus therefor. J. Y. Johnson. (*I.G. Farbenindustrie, Akt.-Ges.*) September 1, 1927.

301,778. Metal carbonyls, Production of. J. Y. Johnson. (*I.G. Farbenindustrie Akt.-Ges.*) September 5, 1927.

301,853. Catalysts for the oxidation of gases with air or oxygen, Manufacture of. B. Lambert and National Processes, Ltd. September 6, 1927.

301,946. Soluble products, Recovery of—from coal and the like. J. Y. Johnson. (*I.G. Farbenindustrie Akt.-Ges.*) September 1, 1927.

301,947. Ethers of 6 : 8-dioxy-quinoline, Process for the manufacture of. A. Carpmael. (*I.G. Farbenindustrie Akt.-Ges.*) September 1, 1927.

301,949. Hydrocarbons, Manufacture of. J. A. A. Zacon. September 7, 1927.

301,955. Petroleum hydrocarbons, Purification of. A. C. Bloxam. (*Allgemeine Ges. für Chemische Industrie.*) September 9, 1927.

301,956. Amino-alkyl ethers of oximes and their salts, Process for the manufacture of. A. Carpmael. (*I.G. Farbenindustrie Akt.-Ges.*) September 9, 1927.

301,969. Catalytic conversion of hydrocarbons, Apparatus for. J. Y. Johnson. (*I.G. Farbenindustrie Akt.-Ges.*) September 15, 1927.

302,041. Water soluble esters of dicarboxylic acids, Manufacture of. J. Y. Johnson. (*I.G. Farbenindustrie Akt.-Ges.*) November 28, 1927.

302,087. Producing metals or alloys together with refractory materials. T. R. Haglund. February 18, 1928.

302,129. Ammonium vanadate and vanadium pentoxide, Manufacture of. J. A. Weil, H. Rawlinson, and Imperial Chemica Industries, Ltd. July 3, 1928.

297,416. Phosphorus or phosphoric acid and binding agents having latent hydraulic properties, Production of. I.G. Farbenindustrie Akt.-Ges. September 21, 1927.

Terms of Nickel Fusion

Statement by Lord Melchett

LORD MELCHETT has issued the following announcement: "A provisional agreement has been signed between the International Nickel Co. of Canada., Ltd., and myself and two other directors of the Mond Nickel Co., Ltd., under which the International Nickel Co., of Canada, Ltd., offer to exchange the preference shares in the Mond Nickel Co., Ltd., for preferred stock in International Nickel Co. of Canada, Ltd., and the ordinary shares of the Mond Nickel Co., Ltd., for ordinary shares, of no par value, in the International Nickel Co. of Canada, Ltd. It is intended to issue to the shareholders of the Mond Nickel Co. on December 28, 1928, a circular containing all the relative information concerning this transaction, and the necessary documents to enable them to execute transfers for exchange.

"I have read in various papers some criticism regarding delay in making an announcement, after my return from America, upon the negotiations on this matter. I should like to draw attention to the fact that it is less than two months since the first statement was issued in New York. In view of the fact that the transaction involved companies situated in three different countries, with different legislations, and with different Company Laws, and as the transaction was one of great complexity, as well as of very great magnitude, it is remarkable that it has been carried to its present stage in so short a time. I doubt whether it is realised that the capital involved in this transaction, at present market prices of the shares, is in the neighbourhood of £120 million. It was impossible to make an announcement which would not be premature and probably misleading until the actual terms had been definitely settled, which was the case only yesterday.

"The new company will be a Canadian company registered in Toronto, Ontario, and its main properties are situated in that province of the Dominion. The Canadian Company Law is based on British Company Law, and both in interpretation in the Courts follow British practice. I would like to emphasise this to British shareholders, as it goes to show them that as far as the rights of shareholders are concerned, the alteration of this seat of registration does not alter the legal practice to which they are accustomed.

Terms of Exchange

"The terms of exchange offered are as follows: For each 7 per cent. preference share held by shareholders in the Mond Nickel Co., Ltd., they will receive a 7 per cent. preferred stock in the International Nickel Co. of Canada, Ltd., and the holders of the first preference shares of the Mond Nickel Co., Ltd., will receive, in addition, a cash payment of 2s. 6d. per share, on account of the higher value attaching to that share, by reason of the fact that holders are entitled, in a winding-up, to a sum of 30s. for every £1 paid. For each ordinary share of 10s. in the Mond Nickel Co., Ltd., holders will receive one share of no par value in the fully-paid common stock of International Nickel Co. of Canada, Ltd.

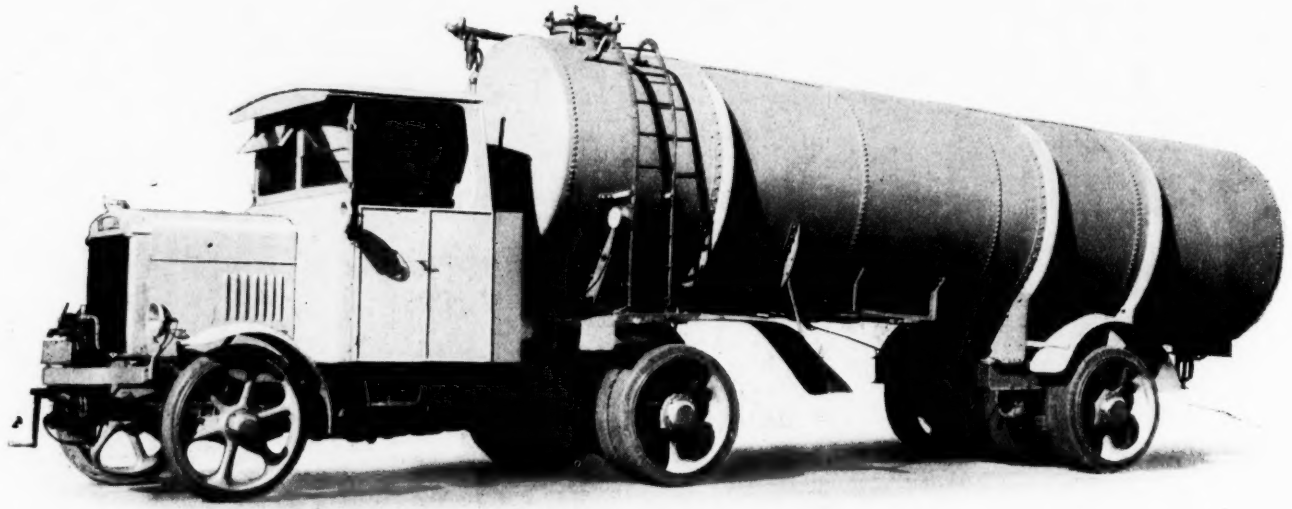
"The future conduct of the business will be carried on by an advisory committee and a board of directors. Owing to the board of the company having, necessarily, to function in Canada, it was impossible for me to take a very active part on that side, but I shall, through my position as chairman of the advisory committee, continue to look after the organisation of the company and the interests of the shareholders. Of the advisory committee, the names and activities of myself, Lord Weir and Sir Harry McGowan, are so well known that I need not say anything further about them. The remainder are Mr. Charles Hayden, a director of a large number of very important mining enterprises, one of the best-known business men in New York; Mr. Robert C. Stanley, who has been largely concerned in directing the nickel industry for many years. Mr. Stanley will continue to act in his old executive position; Mr. J. W. McConnell, one of the biggest industrialists in Montreal and a director of the Bank of Montreal; and Mr. James A. Richardson, of Winnipeg, also one of the leading industrialists in Canada. I want to emphasise the fact that of the advisory committee, there are three British and two British Dominion citizens out of seven.

"The Board of Directors of the Canadian company will be constituted as follows: Mr. C. Hayden (chairman); Mr. R. C. Stanley (president); Lord Melchett; Mr. J. L. Ashley; Mr. J. P. Bickell; Mr. W. N. Cromwell; Mr. D. O. Evans; Mr. R. Halladay; Mr. J. W. McConnell; Sir Harry McGowan; Mr. R. L. Mond; Mr. Britton Osler, K.C.; Mr. J. A. Richardson; Mr. A. V. Stout; Lord Weir; Mr. J. L. Agnew; Mr. W. E. Corey; Mr. J. F. Dulles; Mr. W. T. Graham; Mr. W. J. Hutchinson; Mr. W. W. Mein; The Hon. Henry Mond; Mr. T. Morrison; Mr. S. Prosser; and Mr. G. B. Shipley."

Unemployment in the Chemical Industry

THE NUMBERS OF INSURED PERSONS recorded as unemployed on November 26 in the chemical industry in Great Britain and Northern Ireland, were as follows: Chemicals manufacture, 6,522 (males 5,760, females 762); explosives manufacture, 1,104 (males 724, females 380); paint, varnish, red and white lead manufacture, 866 (males 711, females 155); oil, grease, glue, ink and soap manufacture, 4,611 (males 3,743, females 868).

Scammell Six & Eight Wheelers



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Supplied for carrying :

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Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

London Gazette, &c.

Companies Winding Up Voluntarily

HENRY HODDER AND CO., LTD. (C.W.U.V., 29/12/28). At an extraordinary general meeting of the members of the above-named company, duly convened and held at 5, Nelson Street, Bristol, on Friday, November 30, the following Special Resolution was duly passed; and at a subsequent extraordinary general meeting of the members of the said company also duly convened, and held at the same place on Monday, December 17, the following Special Resolution was duly confirmed: "That the company be wound up voluntarily, and that Edmund Carpenter, of 5, Nelson Street, Bristol, be and he is hereby appointed liquidator for the purpose of such winding-up."

NORTH BRITISH AND HAWKES BAY FREEZING CO. LTD. (C.W.U.V. 29/12/28.) At an extraordinary general meeting of the above-named company held at the registered office of the company, 142, St. Vincent Street, Glasgow, on Tuesday, November 20, 1928, the following special resolution was duly passed, and at a subsequent extraordinary general meeting, on Thursday, December 6, the said special resolution was duly confirmed, viz.: "That the company be wound up voluntarily, and that David Johnstone Smith, C.A., 142, St. Vincent Street, Glasgow, be and is hereby appointed liquidator for the purposes of such winding up. Meeting of creditors at the office of the liquidator, 142, St. Vincent Street, Glasgow, on Friday, December 21, 1928, at 10.30 a.m. The creditors of the company will be paid in full.

THOMPSON AND CAPPER, LTD. (C.W.U.V., 29/12/28.) At Extraordinary General Meetings of the above company, duly convened, and held respectively on November 27 and December 18, the subjoined Special Resolution was duly passed and confirmed:—

"That the company be wound up voluntarily, and that Mr. George Leather, of Messrs. Harmood Banner and Son, 24, North John Street, Liverpool, be appointed liquidator for the purposes of such winding-up."

New Companies Registered

BIDEFORD BLACK, LTD., 24, St. Mary Axe, London, E.C.3, registered as a "public" company on December 20. Nom. capital, £100,000 in 5s. shares. To acquire the business of mineral black manufacturers carried on by Devon Anthracite Ltd., at Bideford, to search for, get, work, make marketable and deal in mineral black, anthracite carbon, coal, oil, chemical substances, mineral dyes, clay and other substances, or products, etc. The purchase consideration is £65,000 (£15,000 in cash and £50,000 in shares.) The company is also to satisfy liabilities amounting to £15,000. Directors: Lt.-Gen. Sir Richard Wapshare, W. L. Nickels, A. L. Broderick, T. Thornton.

THE HUMBER OIL STORAGE CO., LTD.—Registered as a "private" company on December 20. Nom. capital, £65,000 in £1 shares. To carry on the business of storers, dealers, shippers, suppliers, distributors, producers and refiners of oils and spirits of all kinds, products of coal, tar and other substances, etc., to acquire the undertaking carried on at Kellingholme, Lincs., by Major and Co., Ltd., and Ellison and Mitchell, Ltd., and to adopt an agreement with the above and the liquidators thereof and Henry Ellison, Ltd. Directors: J. L. Major, 12, Norfolk Street, Strand, London, W.C.2; H. Ellison, Brookleigh, Calverley, near Leeds; E. Hotham; F. Ellison.

THE MARB-L-COTE DISTRIBUTING CORPORATION, LTD.—Registered as a "public" company on December 19. Nom. capital, £250,000 in 1,125,000 ordinary shares of 4s. each, and 500,000 deferred shares of 1s. each. The objects are to adopt an agreement with the Marb-L-Cote Manufacturing Co. (Great Britain), Ltd., and to carry on the business of manufacturers of and dealers in plastic and other paints and products, lacquers, chemical, industrial and other preparations, compounds, cements, lubricants, oils, pigments, varnishes and the like. A subscriber: A. J. Hook, 70, Holmwood Road, Seven Kings, Essex.

Company News

YORKSHIRE DYEWARE AND CHEMICAL CO.—An interim dividend at the rate of 5 per cent. per annum, less tax, is announced, payable on January 1.

EXPLOSIVES AND CHEMICAL PRODUCTS.—A dividend of 8¾ per cent., free of tax, has been declared, payable on the ordinary share capital for the year ended June 30, 1928, in proportion to amounts paid up at that date.

CAPE ASBESTOS CO.—The 5 per cent. cumulative preference dividend (less income-tax) on the preference shares and a 5 per cent. interim dividend (less income-tax) on the ordinary and preference shares have been declared by the board for the year ending December 31, 1928.

Market Reports

OWING to the intervention of the Christmas holidays no market reports are available for publication this week.

Colour, Chemical, and Dye Merchant's Affairs

UNDER a receiving order made against his estate, on the petition of L. B. Holliday and Co., Ltd., of Deighton, near Huddersfield, creditors for £105, the statutory first meeting of creditors of Mr. F. Smith, colour merchant, 10, Philpot Lane, London, who has also been engaged in the chemical and dye trades, was held on Thursday, December 20, at Bankruptcy Buildings, Carey Street, London. It appeared from statements that had been made by the debtor that he was formerly in employment for many years. In 1914 he began to deal in dyes and colours from 56, Gracechurch Street, London, and in February of the following year he was joined in partnership by one R. A. Larcombe. The trading proved a success until the latter part of 1926, and he had no reason to suppose that his partner was drawing amounts in excess of his share of the partnership profits. In April, 1927, he (Frank Smith) applied for and obtained an order for dissolution of the partnership, and the receiver appointed under the order of the Chancery Court sold the business, so he understood, in consequence of inability to meet the pressure of trade creditors. Since the release of the receiver he has been unable to take any further steps to pay the firm's creditors and he has been dependent on his earnings from dealings in dyes and colours. The present petition was filed by a creditor, a receiving order being obtained against the partners in the old firm severally. The debtor attributed his insolvency to liability for the partnership debts through the alleged default of his partner, and he estimated his liabilities at £2,300. He said that his assets consisted of £820, represented by the amount paid into Court by the purchaser of the old business of Smith, Larcombe and Co., less liability to the purchaser and the receiver's expenses. The meeting resolved that no trustee be appointed other than the Official Receiver, in whose hands the estate of the debtor accordingly remains.

Limitation of Exhibitions

Forty Countries Sign Paris Convention

DELEGATES from forty nations attended an International Conference for the Limitation of Exhibitions in Paris recently, when a convention was signed agreeing to limit the number of general long-period exhibitions which are officially recognised to once in 10 years at the least in the same country, and once in two years at least in all countries. Special exhibitions confined to one trade or industry are limited less strictly. The convention does not apply to any exhibitions which do not seek official recognition or to sample fairs such as that of Lyons or the British Industries Fair.

Sir Edward Crowe pointed out that as far back as 1912 the German Government had laid the foundations of an understanding on the subject. For a long time the British Government had examined this question, at once so complex and so embarrassing, and they had asked themselves how they might be able to find the best and quickest solution. Happily, the French Government had taken the initiative, and it was with the greatest alacrity that Great Britain had accepted France's invitation.

The China Clay Trade Review

The Official Organ of the China Clay Industry and the only Journal specially devoted to its interests.

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For Slime, Clay, Sand, Gravel, Stone, Water, Pressure
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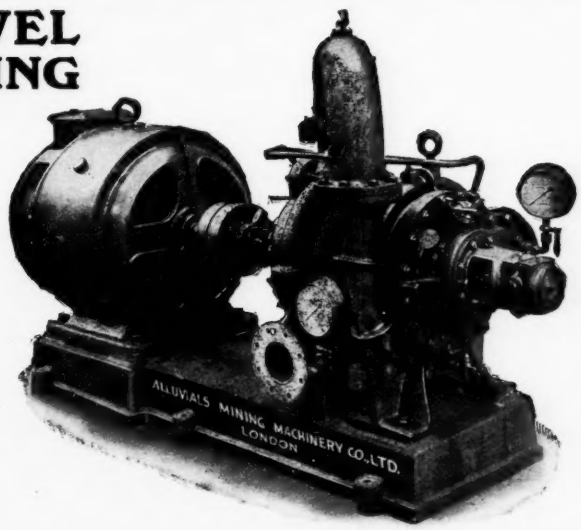

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British Ropeway Engineering Co., 7, Mincing Lane, London.

AUCTIONEERS.
Hancock & Sons, Sydney Place, St. Austell.

BAGS AND LINERS (COTTON).
Feltham, W. H., & Son, Tower Bridge Road, London, S.E.1.

BANKS.
Barclays Bank, Limited.

CANVAS GOODS.
The N.F. Waterproofing Co., Ltd., Woodside Lane, N. Finchley, N.12.

CHINA CLAY AND CHINA STONE.
Best, Jas., & Sons, Longport, Stoke-on-Trent.
Bloomdale China Clay Co., Ltd., 80, Bishopsgate, E.C.
Burthy China Clay Co., Y.M.C.A. Buildings, St. Austell.
Carbis China Clay & Brick Co., Y.M.C.A. Buildings, St. Austell.
Catalpo, Ltd., London.
Consolidated Mines of Cornwall, 32, Seething Lane, E.C.
Dartmoor China Clay Co., Ltd., 11, Queen Victoria St., E.C.4.
Dyer, Samuel J., Market Hill, St. Austell.
English China Clays, Ltd., St. Austell.
Fox, Roy & Co., Plymouth.
Grose & Stocker, Stoke-on-Trent.
Lovering, J., & Co., St. Austell.
New Halwyn China Clay Co., Y.M.C.A. Buildings, St. Austell.
Newquay China Clay Co., Ltd., Newquay, Cornwall.
North Goonbarrow China Clay, Ltd., 3, Victoria Place, St. Austell.
Parkyn & Peters.
Pochin, H. D., & Co., Manchester.
Somerset Oxide and Ochre Co.
Tehidy Minerals, Ltd., 3, St. Petroc House, Bodmin, Cornwall.
Trethowal China Clay Co., Y.M.C.A. Buildings, St. Austell.
United China Clay Co., Ltd., 80, Bishopsgate, E.C.2.
Varcoes China Clays, Ltd., 107, Market Street, Manchester.
West Carclaze China Clay Co., St. Austell.
Wood, T.A.V., Ltd., Grant's Walk, St. Austell.

COALS.
Cornish Mines Supplies Co., Ltd., St. Austell.
Dunkerton Collieries, Dunkerton, near Bath.
H. Rees Jones & Co., Cardiff.
Stockwood, Rees & Co., Ltd.
Welsh Navigation Steam Coal Co., Ltd., Cardiff.

COLLIERIES.
Dunkerton Collieries, Ltd., Dunkerton, near Bath.
Rees Jones & Co., Ltd., Cardiff.

COLOURS AND CHEMICALS.
Brown, R. B., & Co., 45, Finsbury Square, E.C.
Podmore, W. & A. J., Caledonian Mills, Shelton, Stoke-on-Trent.

ELECTRICAL ENGINEERS.
Harry H. Gardam & Co., Ltd., Staines.

ENGINEERS.
Holman Bros., Camborne.
Paulls (Engineers), Ltd., Fowey.
Sidney Smith & Blyth, Ltd., Garratt Lane, Wandsworth, S.W.18.

FILTERPRESS.
Premier Filterpress Co., Finsbury Pavement House, E.C.

GAS ENGINES.
Crossley Bros., Ltd., Manchester.

IRONMONGERS.
Cornish Mines Supplies Co., Ltd., St. Austell.
Stocker, F. E., Ltd., St. Austell.
Hawke & Son, St. Austell.

LAND & MINE SURVEYORS.
Trythall & Champion, Camborne.

LUBRICANTS.
Cornish Mines Supply Co., Ltd., St. Austell.
Reliance Lubricating Oil Co., Ltd., 19–20, Water Lane, E.C.
Willcox, W. H., & Co., Ltd., 32–38, Southwark Street, London, S.E.1.

MINING ENGINEERS.
Rich, Wm., & Sons, Redruth.

MINING MACHINERY.
Alluvials Mining Machinery Co., 2, Broad Street Place, E.C.
Cornish Mines Supplies Co., Ltd., St. Austell.
Hadfields, Ltd., East Hecla Works, Tinsley, Sheffield.
Rich, Wm., & Sons, Redruth, Cornwall.

MINING SUPPLIES.
Cornish Mines Supply Co., Ltd., St. Austell.
Hadfields, Ltd., East Hecla Works, Tinsley, Sheffield.
Holman Bros., Camborne.
Rich, Wm., & Sons, Redruth, Cornwall.

MOTOR TRANSPORT.
Mid-Cornwall Transport Co., Ltd. (1922), Bodmin Road, St. Austell.

PIPES.
British Mannesmann Tube Co., Ltd., Salisbury House, London Wall, E.C.2.
Ryland, A., Cradley Heath, Staffs.

PUMPS.
Alluvials Mining Machinery Co., 2, Broad Street Place, E.C.
Cornish Mines Supplies Co., Ltd., St. Austell.
Willcox, W. H., & Co., Ltd., 32–38, Southwark Street, London, S.E.1.

QUARRYING AND MINING REQUISITES.
Cornish Mines Supplies Co., Ltd., St. Austell.
Hadfields, Ltd., East Hecla Works, Tinsley, Sheffield.
Rich, Wm., & Sons, Redruth, Cornwall.
Warden, F. H., Ltd., Birmingham.

RAILS (Bridge, Flange, Double or Bullhead).
Bute Works Supply Co., Ltd., 53, Cymric Buildings, Cardiff.

RAILWAY WAGONS.
Bute Works Supply Co., Ltd., 53, Cymric Buildings, Cardiff.
Roberts, Charles, & Co., Ltd., Horbury Junction, nr. Wakefield.

ROPES.
Cornish Mines Supplies Co., Ltd., St. Austell.

SHIPBROKERS.
Blake, G. A., 11, High Cross Street, St. Austell.
Ludlow & Sons, Penzance.
Simpson, Spence & Young, London.
Toyne, Carter & Co., Fowey.

SACKS & BAGS.
Andrew Weir & Co., 21, Parliament Street, Liverpool.
Boag, Thos., & Co., Ltd., Greenock.
Cornish Mines Supplies Co., Ltd., St. Austell.
Dovener, J. H., & Co., Union Street, Liverpool.
North Mills Co., Ltd., Little Peter Street, Manchester.
The N.F. Waterproofing Co., Ltd., Woodside Lane, N. Finchley, N.12.

TIMBER IMPORTERS.
Cornish Mines Supplies Co., Ltd., St. Austell.
Fox, Eliott & Co., Plymouth.
T. Warne, St. Austell.

WATERPROOFING.
The N.F. Waterproofing Co., Ltd., Woodside Lane, N. Finchley, N.12.

WIRE ROPES.
Hood Haggie & Son, Ltd., Newcastle-on-Tyne.
Stephens, John, & Son, Ltd., Falmouth, England.

The China Clay Trade Review

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China Clay in Parliament

WITH reference to the question that has arisen as to the eligibility of the China Clay industry for relief under the Government's de-rating proposals, it was felt that the pronouncements made last month were hardly definite enough. In the intervening month, the Government departments, under pressure from Mr. George Pilcher, the energetic M.P. for the Penryn-Falmouth Division, in which most of the China Clay works are situated (St. Austell being now a part of the Penryn-Falmouth Parliamentary Division), have taken definite legal advice with regard to the matter, and the conclusion that has been arrived at, as will be seen by the details published elsewhere in this issue, is that the question is now placed beyond all doubt, so that when the operations of the Act are in force, the China Clay and China Stone industry of the West of England will receive the relief.

Following upon the departmental pronouncement referred to, the matter was further raised in Parliament, and the points raised were interesting in view of the exhaustive nature of the questions put, and the very definite replies given by Mr. Neville Chamberlain. Mr. Chamberlain appeared to be somewhat taken aback at the anxiety of members who spoke for the various quarrying interests, which may now rest assured that there will be definite provisions in the Act so as to lift it beyond all question that the China Clay, China Stone, and allied quarrying industries will come within the scope of the Act.

American China Clay and English Producers

Last month something of a bombshell was thrown into the British China Clay camp by a highly coloured article in an American paper published in Georgia, one of the Southern States, in which not only was a British China Clay firm said to be making a survey of the domestic clay position and deposits, but that it was the intention of the British firm referred to (English China Clays, Ltd.) to engage in the production of Georgia domestic clays. Since then, as will be seen by the particulars of the subject elsewhere in this issue, Mr. Goldman, of the English China Clay Sales Corporation, who operate from New York, and Mr. Walter Sessions, of English China Clays, Ltd., St. Austell, have published a letter in reply to the article, parts of which were reprinted in West of England papers, in which they declare that the interview in the American paper, intimating that it was the intention of their firm to start the production of clay, never took place.

It is quite true, as Mr. Sessions in his letter points out, that from time to time British China Clay producers connected with China Clay producing firms have paid visits to the domestic China Clay areas of America out of curiosity, just as American business men interested in China Clay have, from time to time, paid visits to the China Clay areas of Cornwall and Devon.

The Business Point of View

While the denial of Mr. Sessions must, of course, be accepted, it must be said that when the information in the alleged interview was published, not a few merchants interested in China Clay production thought it a good business move for a British firm to interest itself in American domestic China Clay production to supply those markets which use and prefer to substitute domestic clays for British imported clays. After all, British China Clay producers may be said to be the pioneers of China Clay production, producers in other countries not having appreciated the value of China Clay as a raw material, or produced it, until after British producers had exploited it and found markets for it in all parts of the world. This being the case, it seemed to be only natural and a matter of business enterprise for the original producers of China Clay to wish to supply it to the world markets, and to supply those markets with the particular brand of China Clay which users prefer. Undoubtedly, British China Clay producers are supplying American users with all the British China Clay they can induce them to take, but in many cases, as is revealed by the fact that the consumption of domestic clays in the States and Canada is increasing as much as, if not more than, that of the British product, there seems no reason, from the business point of view, why British producers should not enter the American production field to supply those markets which are not now supplied, and will not be supplied with the British-produced commodity. This would be only on a par with the step taken last year by an American firm in the acquisition of certain British China Clay works, from which they are now supplying the American market with the British product.

American Domestic Clay Competition

On the general question of the competition of American domestic clays in markets which are being or have been supplied with British products, the fact has to be faced that nowadays, in consequence of the strides made in the production of American domestic clays, it is not easy to induce buyers to use British China Clays in preference to the domestic article in certain markets, particularly those within a reasonable distance of the areas of production, and especially as regards the cheaper grades.

As has been mentioned previously, individual firms have from time to time made investigations into the position of American domestic China Clay production, but apparently there has never been any concerted effort made by the China Clay industry as a whole with a view to rectifying the anomalies and differences which now arise from competition by both classes of producers, and to stabilising the position in the interests of both classes of producers and, incidentally, in the interests of consumers of China Clays whether produced in England or America. The time would seem to have arrived when both classes of producers might get together and consider the possibility of working in co-operation, rather than in unnecessary and oftentimes unprofitable competition.

American Visitors in Clay District

Representatives of American Ceramic Society Entertained

AFTER a Continental visit, delegates of the Ceramic Society of America arrived in England towards the end of June for their tour of the Cornish China Clay district, the Potteries, and Shakespeare's country. They were entertained in London, and at the week-end the main party entrained for the Midlands, while a section interested in the production of China Clay travelled to Cornwall by special saloons, and arrived at the Hotel Victoria, Newquay, in the early hours of Sunday morning.

At 10.30 on Sunday morning a G.W.R. motor bus was placed at the disposal of the party for a trip to Falmouth and Penzance. The weather was glorious, and the visitors saw the county at its best, and were loud in its praises. They returned to Newquay and were entertained to dinner at the Hotel Victoria, their hosts being the China Clay Association (Associated China Clays, Ltd.). The arrangements for the itinerary were made jointly by a committee representative of the home China Clay producers and the American importers of China Clay. Mr. Walter Sessions was at the head of the home China Clay producers' committee, and Mr. M. Marks and Mr. Brian acted similarly for the American importers. Through indisposition, Mr. Marks was unable to join the party on Sunday.

The visitors included Messrs. S. Goldman (New York), Geo. Simcox (New Jersey), T. C. Denis (Quebec), G. W. Lapp (New York), C. Brian (Easton, Pa.), F. Sutterling (New Jersey), W. Cannan (Syracuse), R. E. Elliott (Quebec), M. A. Gesner (New York), W. G. Jackson (Los Angeles), W. L. Shearer (New Jersey), A. J. Bennett (New Jersey), and Madame Denis (Quebec). Representatives of the China Clay industry included Mr. J. Rogers (Wheal Remfrey), Messrs. Walter Sessions and Hart Nicholls (English China Clays, Ltd.), Mr. F. Parkyn (Parkyn and Peters), Mr. C. O. Rowe (Wheal Prosper), Mr. E. J. Hancock (West Carclaze), Mr. W. T. Lovering (J. Lovering and Co.), Mr. J. M. Coon, Mr. J. Hoyle (Manchester China Clay Co.), Mr. A. Perry (Perry Brothers), Messrs. F. S. Liddicoat, J. Maddocks, and T. Warne (Anchor United and Melangoose China Clay Companies), Mr. Wilfred Sessions (Newquay China Clay Co., Ltd.), Mr. C. S. Varcoe (Varcoes China Clays, Ltd.), and Mr. S. Lovering. A number of ladies were also present.

Welcome by China Clay Producers

In welcoming the members of the Society, Mr. J. Rogers said he presumed that one reason why he was placed in that position of honour was because he was one of the oldest members of the China Clay trade. They appreciated the fact that the visitors had come down to Cornwall on that occasion to enjoy themselves, and he took that opportunity on behalf of the clay trade to give a hearty welcome to their friends from overseas. They were glad to see them, their only regret being that more of the party had not joined them. Those who had come down were a fine set of men, well worthy to represent such a big country as the U.S.A.

In proposing the toast of "The Visitors," Mr. J. W. Higman said that the China Clay industry welcomed them with the greatest possible pleasure. He had had the pleasure on many occasions of visiting the United States, where he had many friends, who, whenever he went there, were most kind and hospitable. Other friends in the clay trade had received similar kindness, and it was only a duty and pleasure on their part to reciprocate the kindness they had received on the other side.

Appreciation of the Visitors

The toast was accorded musical honours, and in responding Mr. Elliott spoke of the unqualified cordiality and generosity with which they had been received and entertained. From the time they had set foot in Europe their trip had been characterised by such a crescendo of entertainments that he was almost glad they were going to get away within a few days, because if that crescendo was maintained at that very high note they would all be simply incapacitated. Someone had remarked to him that he had left the best until last, and he believed that was so. Nothing could have exceeded the pleasure they had had that day, and their regret was that the whole party could not accompany them; it was their loss. The hospitality the clay industry had shown them had certainly not been exceeded on their trip. Referring to such trips as opportunities for the exchange of ideas and knowledge, "we feel," he said, "that your interests are in almost every case our interests, and we may reasonably expect these visits to continue in the interests of their respective endeavours." They would welcome the return of such visits at any time, feeling that it was to the advantage of all to exchange visits as frequently as possible.

Mr. Elliott then submitted the toast of "Our Hosts." Mr. Frank Parkyn, responding first, referred to the fact that he joined the party in London on Friday, and testified to their enjoyment of the entertainment London had to offer. Mr. Walter Sessions, also responding, acknowledged the presence of all who had come to assist at that gathering, and the pleasure it gave all of them representing the home China Clay producers to welcome their American friends there. Not only were there represented those who produced British China Clays, but also those engaged in the production of American and Canadian domestic clays. They were all very good friends, although they were producing in three different markets. He had a very warm place in his heart for America and the American people. He had been visiting America ever since 1882, when he was there for nearly a year, and had been going to and fro ever since, having paid six visits in the last 15 months. He always liked to think that the Americans were their cousins.

Tribute to G.W.R.

The Chairman, in submitting the toast of the G.W.R., referred to the complete way in which the latter body had responded to their every requirement in catering for the convenience of their visitors, and to the way in which Mr. R. H. Nicholls, superintendent of the line, whom they were delighted to welcome amongst them, had looked after the comfort of their guests. Mr. Nicholls, he said, was a very important unit in the G.W.R. staff, and from the time the arrangements were handed over to him by Sir Felix Pole, nothing had been left undone to make the trip a success. The G.W.R. put on two sleeping coaches and a dining saloon, so that their friends could travel down through the night, and were putting on a special saloon for them to make the journey to Birmingham. Alluding to the progressive policy pursued by the G.W.R., Mr. Rogers said it was undoubtedly one of the most progressive lines in the country. They in Cornwall had an asset beside China Clay, namely tin, and yet another, their climate and scenery. What would Cornwall have been without the G.W.R.? The G.W.R. was a great asset in calling attention to the county, both as a winter and summer resort. He referred in this connection to the direct services now run from London to Cornwall, particularly the 10.30 a.m. from Paddington, which with one stop reached Truro at 4 o'clock. A very large number of people in Cornwall had cause to thank the G.W.R. for what they had done in popularising the county, and he hoped they would continue to do so.

Responding, Mr. Nicholls, after recalling the unexampled kindness he had received at the hands of the Americans on his only trip to that country, expressed satisfaction that the services of the G.W.R. were appreciated. Speaking of his company, he said it was enormous pleasure for the G.W.R. to do everything they could for them on every possible occasion. His parting wish was "God Bless America."

Mr. Elliott, in a word of thanks on behalf of his friends, spoke of the G.W.R. as a wonderful railway, and added the testimony that in no other country they had visited had they experienced such a wonderful service as they had on the G.W.R. Mr. Brian said there was every reason why the Americans and the English should get on well together—they spoke the same language and were of one blood. Why should they not like each other?

Clay Works Visited

On the next day the company were early astir for their tour of inspection of the clay works in the neighbourhood of St. Austell. Mr. Walter Sessions, on behalf of Associated China Clays, Ltd., and Mr. Brian, representing the American importers of China Clay, acted as escorts, and were accompanied by other representatives, including Mr. Alfred Davies, Mr. Hart Nicholls,

Mr. F. S. Liddicoat, and Mr. Maddocks. Later they were joined by Mr. E. J. Hancock and Mr. M. Marks (chairman of the Importers' Committee).

The party visited a typical China Clay works, which, though only worked 35 years, now reached a depth of 220 ft. and was about 18 acres in circumference. Here they were shown the internal arrangements of the pit, which most of the party descended, and afterwards inspected the refining troughs and settling pits. Afterwards a visit of inspection was paid to a China Stone quarry, from which are extracted various grades of stone used in the ceramic industry. Mr. Walter Sessions presided at luncheon, after which the party inspected the final plant in the preparation of China Clay for the market—the drying process at the kilns. The party then left for their reserved saloon at St. Austell Station for their trip to Birmingham, where they were joining the main party. At the station, Mr. J. W. Higman joined the hosts in bidding farewell to the visitors, who were profuse in their thanks and expressions of appreciation for the splendid hospitality extended to them.

China Clay and Rating Relief

China Clay Industry Embraced by Government Proposals

When Mr. George Pilcher, M.P. for the Penryn-Falmouth Division, approached Mr. Neville Chamberlain and Mr. Winston Churchill for specific assurances that the China Clay industry would come within the scope of the Government's de-rating proposals, he received the assurance that it appeared likely that such would be the case. Subsequently the Minister of Health took further legal advice on the specific question whether China Clay works really came within the scope of the Rating and Valuation (Apportionment) Bill. It is the definite character of this legal pronouncement that has finally settled the question. The opinion of counsel is contained in the following interesting details of the process of deduction which led him to advise the Ministry affirmatively.

Counsel's Opinion Cited

The following is the full text of the relevant portion of counsel's opinion :—

" I think Mr. Pilcher may be given the fullest assurance that China Clay works will be industrial hereditaments within the meaning of the Bill. It seems clear that the China Clay works with which Mr. Pilcher is familiar are not mines, but in my opinion the places described by him are quarries, though even if they were not, they would fall within the definition in the Bill of an industrial hereditament. For the purposes of the Factory and Workshop Act, 1901, I do not think it is material that there is little, if any, cutting process, or that such cutting process as there is was done long ago. It is true that the Quarries Act, 1894, applies only to quarries more than 20 ft. deep, but that limitation does not apply for the purposes of the Factory and Workshop Act, 1901.

Famous Test Case Recalled

" The process of getting China Clay was fully described in the plaintiff's evidence in the case of Hext *v.* Gill, L.R. 7 Ch. (1872), page 703. That passage of the evidence (which was read by Lord Justice Mellish) formed the basis of the judgment, which decided that China Clay was included in a reservation of minerals. The description given in that case is almost identical with the description given by Mr. Pilcher of the modern process of getting China Clay, and I do not think there can be any doubt that for the purposes of the definition of ' quarry ' contained in Part 2 of the sixth schedule to the Factory and Workshop Act, 1901, China Clay is a mineral. For another case in which China Clay was held to be a mineral see G.W.R. Co. *v.* Carpalla China Clay Co., Ltd., 1910, A.C. 83.

" Even supposing, however, for the sake of argument, that there could be some place in which China Clay is got which is neither a ' mine ' nor a ' quarry,' that place would nevertheless fall, in my opinion, within the general definition of ' factory ' and ' workshop ' contained in Section 149 of the Factory and Workshop Act, 1901, for it would be a place in which ' manual labour is exercised by way of trade, or for purposes of gain in, or incidental to ' the purpose of ' the making of an article,' viz., China Clay (or ' the adapting for sale of an article ').

" Attention should also be drawn to sub-section (5) of the section in question, which provides that a place or premises shall not be excluded from the definition of ' factory or workshop ' by ' reason only that the place or premises is, or are, in the open air."

House of Commons Discussion

In the House of Commons the following interesting discussion took place on the question of quarries in their relation to the Government's rating proposals. Mr. Percy Harris (L., Bethnal Green) moved an amendment to insert the word " quarry " after the word " mine " in section 3 of the Rating and Valuation Bill. Mr. Chamberlain assured him that a quarry was included in the term " factory or workshop " in the Factory and Workshop Act.

Sir Henry Slesser (Lab., Leeds) pressed the Minister to develop this definition. Mr. Chamberlain said that the question had been examined by his expert officials at some length because it had been raised, and therefore he could speak with some confidence on the matter. " I would say," he continued, " that all the quarries that I have noticed will be included within the scope of the Bill. If there is any particular kind of quarry which the honourable and learned gentleman has in mind, and he will give me information on that point, I will either give him an assurance as to that particular quarry, or I will take care that provision is made to meet the case."

Sir H. Slesser : " The case I have in mind is a quarry where there is no mechanical process of working, and where power is not used, and yet the work done is clearly of a productive character in the same way as in the case of a mine. But it is not a factory in any sense of the word, because no power is used there, and there is no mechanical process."

Mr. Lloyd George : " Would a slate quarry or a sett quarry be included ? In the case of a sett quarry, macadam is obtained from it for use on the roads."

Mr. Chamberlain : " Yes, certainly both these cases are included.

Minister's Emphatic Assurance

Mr. Harnay (Lib., South Shields) raised the question of China Clay. It was quite clear, he said, that quarries were not included in mines, and the only way in which you could get them included was under the Factories Act, where it said : " Quarries—that is to say, any place not being a mine in which persons work in getting slate, stone, or other minerals." In those circumstances, he thought they did need some definite assurance that, say, the China Clay mines in Cornwall, the granite quarries, the slate quarries, the quarries from which road stone was produced, and places of that kind where real productive work was done, would be included in the rating provisions of the Bill.

Mr. Dixey (Con., Cumberland) : " Is a granite quarry included in the definition ? "

Mr. Chamberlain : " I cannot understand why hon. Members are so nervous. I have given assurance that I have looked into the matter and had it specifically examined, and I am quite confident that under the terms of the Bill quarries are included. My hon. friend asks me about granite quarries. A quarry is defined under the Factories and Workshops Acts as ' any place, not being a mine, in which persons work in getting slate, stone, and so forth.' Granite is stone. Limestone is also stone."

Mr. Kelly (Lab., Rochdale) : " I want to be satisfied about the China Clay industry of Cornwall. I want to know if that has been considered."

Mr. Harris : " I ask leave to withdraw on the Ministers' assurance."

The amendment was by leave withdrawn.

The reason why the Cornish Members took no part in the debate was that they already knew that the mines and quarries and China Clay works were included in the scheme.

American Ceramic Society in the Midlands

Members of the American Ceramic Society, in the course of their visit to England, paid a visit to Birmingham and the Midlands during the last week in June. They first visited Birmingham, where they were the guests at luncheon of the Chamber of Commerce. They were also given a civic reception at Stoke-on-Trent, and entertained to luncheon by the N. Staffs Ceramic Society, and to dinner by the British Pottery Manufacturers' Federation. The party inspected the glass and refractory industries of Stourbridge, and the china industry of Worcester.

China Clay Notes and News

China Clay Sales Company Formed

ENGLISH CHINA CLAYS SALES CO., LTD.—Private company. Registered June 15, 1928. Capital, £1,000 in £1 shares. Objects: To carry on the business of buyers and sellers of China Clay, China Stone of all kinds, bricks, brick earths, tiles, pottery, etc. The first directors (to number not less than three nor more than twenty) are: T. M. Stocker, Trelawney, St. Austell (managing director of English China Clays, Ltd.); H. Stocker, Boughmead, St. Austell (director of English China Clays, Ltd.); H. S. Andrew, Tregarne Terrace, St. Austell (director and secretary of English China Clays, Ltd.). Remuneration (except managing directors): as fixed by the Company. Solicitors: Gregory T. Rowcliffe and Co., 1, Bedford Row, W.C. Registered offices: High Cross Street, St. Austell.

British Firm Denies American Reports

Last month there were published in West of England papers quotations from an article and alleged interview in an American paper to the effect that English China Clays, Ltd., contemplated the extension of China Clay production to American deposits in Georgia. Mr. Walter Sessions, joint managing director of English China Clays, Ltd., and Mr. S. Goldman, head of their New York organisation, were said to have made a "survey" of certain deposits, and to have declared in an interview that their company would "establish a large plant somewhere in Georgia, provided a large deposit of the proper quality can be located accessible to a rail line. So far we have not found what is desired, and since our survey is not complete, we cannot say what report will be made to the company."

On the newspaper article being brought to the notice of the two gentlemen mentioned, they gave an emphatic denial to the statements made in the article, and Mr. Sessions issued the following letter for publication in the Press:—

"My name has been coupled with the name of Mr. S. Goldman as having been interviewed in America by a representative of the *New York Press*, and we are quoted as having made certain statements. The interview recorded never took place with Mr. Goldman and myself. The first intimation we had that such statements had appeared in American papers was the article appearing in the local Press.

"Both Mr. Goldman and I have paid visits at different intervals to some of the China Clay mines of the southern states of the United States of America, as well as in Canada and other parts of the world. In May last we paid such a visit to Georgia and South Carolina. As a producer of China Clay in England it has always been of interest to know what can or cannot be produced commercially elsewhere. Friends of ours from America paid similar visits to our mines in Cornwall periodically. It is easily understood that an 'inspired' article of the character as published might be used to assist those engaged in the American China Clay industry."

Wasted China Clay

At the last meeting of the St. Austell Urban Council, the Surveyor made a serious complaint with regard to China Clay on the roads. He said in the Tregonissey district, from Treverbyn Road downwards through Tregonissey particularly, the droppings had been very bad lately. The effect of that China Clay, not only from the point of view of the dust, but from the point of view of the effect on the road surface, was a very serious matter. As things were, the tar would be gone by September, though it ought to stand practically all through the winter. Whether it was a question of overloading or of not loading properly, he did not know. The clay on the roads was also a danger to traffic in wet weather. Councillor Galley supported the complaint, and moved that a letter be sent to those responsible for sending out the clay. Councillor Watkins said he believed that the Council had power to prosecute people who were responsible for such droppings on the roads, though he did not want them to do anything to hamper the carriage of clay. The Clerk (Mr. G. B. Dobell) said he would like to have the whole matter discussed further in Committee.

The Chairman (Mr. H. Hodge) said it was a very serious matter for their roads. They realised what the clay meant to the district, but he thought the trouble could be remedied, particularly by the use of motor lorries in place of the horse wagons now employed, which method had been employed from the beginnings of the industry. It was decided to discuss the matter further.

China Clay: Three Years' Exports

Preliminary figures for 1927 indicate an export of 661,826 long tons of China Clay during that year, as compared with 651,990 in 1926 and 652,576 in 1925. A satisfactory feature of the export trade in 1927 was the gradual improvement in overseas markets. Belgium took the largest share of English shipments of China Clay to Continental Europe. Germany, while still a long way behind its pre-war receipts of 90,000 tons per annum, is gradually creeping up in the export list, and in 1927 reached its highest total since the war. Exports to the United States decreased markedly during December, 1927, amounting to only 16,251 tons, as compared with 26,837 during December, 1926, a decline of almost 40 per cent. Figures for the whole of 1926 and 1927 reveal that the annual export to America also showed a decided drop, amounting to about 27 per cent. The following table contains the available export figures for 1927 as compared with the statistics for 1925 and 1926:—

DESTINATION.	1925. Long tons.	1926. Long tons.	1927. Long tons.
Belgium	56,755	64,891	65,448
France	33,090	31,129	28,975
Germany	26,721	27,893	33,885
India[1]	—	—	36,941
Italy	32,044	23,697	22,781
Netherlands	42,113	40,421	50,512
Scandinavian countries[2]	63,637	49,203	71,564
Spain	13,445	15,646	18,502
United States	345,506	361,797	274,093
Other countries[3]	39,265	37,313	59,125
Total	652,576	651,990	661,826

[1] Included under "Other countries" in 1925 and 1926.
[2] Includes Norway, Sweden, Denmark, and Finland.
[3] Includes British countries—Africa, Canada, etc.

American China Clay Output

A recent United States Consular report contains a notice of the course of the China Clay trade last year, when the production of China Clay reached a record output of 997,269 long tons, just short of the million mark. The highest previous record was attained in 1912, when there was an output of 963,895 tons, including 73,284 of China Stone. The 1927 total, consisting of 920,074 tons of China Clay, 54,551 of China Stone, and 22,644 of Ball Clay, compared with an output of 934,360 tons in 1926. All three items showed increases, although in the case of Ball Clay the difference was unimportant.

Czechoslovakian Rough Ceramic Industry

The Department of Overseas Trade has received from the Office of the Commercial Secretary in Prague the following summarised translation of the official report issued by the rough ceramic and building ceramic industry covering the situation in 1927. Improvement in the economic situation during 1927 was visible in this industry, whose principal consumers, the iron and steel industry, the glass industry, porcelain manufacturers, tile factories, and lime works, were employed to a considerably greater capacity. The raw materials, kaolin, clay, quartz, and felspar, were of better quality, as were the goods produced. The home market in 1927 was somewhat more favourable than during 1926. The foreign market, however, could be more profitably exploited if high freight rates did not hamper exports. In this industry, which consigns goods in bulk, freights play an important part. The Czechoslovak State Railways have, indeed, made some concessions in this matter during 1927, but these remain insufficient. The industry will, therefore, be forced to press for further concessions for reduction of the freights on coal and rebate on the coal tax, as also for a reduction of the social burdens on industry.

In consequence of these difficulties prices were low throughout the year, and capital was scarce for extension and modernisation purposes. The latter factor forms a further handicap in competing with foreign factories which are equipped with the most modern machinery.

Shipping and Export News of the Month

We give herewith latest particulars relating to arrivals and sailings of ships engaged in the China Clay trade, at the principal British clay ports. Registered exports of China Clay, with countries of destination, and other shipping and export matters are dealt with.

Fowey Shipping—June, 1928

Arrived.	Name.	Sailed.	Destination.
June 1,	M.V. *Grit*	June 4,	Purfleet
June 1,	M.V. *Shortest Day*	June 5,	Pentewan
June 1,	M.V. *Hope*	June 5,	Pentewan
June 2,	S.S. *Blush Rose*	June 6,	Rouen
June 2,	S.S. *Mersey*	June 5,	Ridham
June 4,	S.S. *Florentino*	June 5,	Genoa
June 4,	S.V. *Ethel Everard*	June 5,	Pentewan
June 5,	M.V. *Romanie*	June 7,	Gijon
June 5,	S.S. *Matje*	June 8,	Glasson Dock
June 6,	S.S. *Inga*	June 7,	Odense
June 6,	S.S. *Hayle*	June 9,	Runcorn
June 6,	S.S. *Brier Rose*	June 7,	Fleetwood
June 6,	S.S. *Gouwestroom*	June 8,	Amsterdam
June 7,	S.S. *Wilhelm*	June 8,	Riga
June 7,	M.V. *Lydia Cardeil*	June 12,	Weston Point
June 8,	M.S. *Skroger*	June 11,	Halden
June 8,	M.V. *Kathe Jurgensen*	June 11,	Trangsund
June 8,	M.V. *Tarragona*	June 19,	London
June 8,	S.V. *Ryelands*	June 21,	Weston Point
June 8,	S.V. *W. E. Gladstone*	June 12,	Plymouth
June 8,	S.S. *Primrose*	June 12,	Antwerp
June 8,	M.V. *Hope*	June 12,	Kingsbridge
June 10,	S.S. *Mersey*	June 11,	Ridham
June 11,	S.V. *Naiad*	June 16,	Erith
June 11,	S.S. *Warlaby*	June 19,	Norfolk Va.
June 12,	S.S. *Westdale*	June 13,	Liverpool
June 12,	S.S. *Scheldejol*	June 13,	Terneuzen
June 13,	S.S. *Blush Rose*	June 15,	Barrow
June 13,	S.S. *Guelder Rose*	June 14,	Runcorn
June 13,	S.V. *Waterwitch*	June 18,	Newcastle
June 13,	S.S. *Sturdee Rose*	June 16,	Ghent
June 14,	S.S. *Wild Rose*	June 15,	Brussels
June 14,	S.S. *Joffre Rose*	June 16,	Rouen
June 15,	S.S. *Torpoint*	June 17,	Paimpol
June 15,	S.V. *Trevellas*	*	*
June 16,	M.V. *Kongedybet*	June 19,	Karlskrona
June 16,	S.S. *Gouwestroom*	June 20,	Amsterdam
June 17,	S.S. *Forthbridge*	June 25,	Boston
June 18,	S.S. *Ravenspoint*	June 21,	Genoa
June 18,	S.S. *Enterpriser*	June 20,	Gravelines
June 19,	S.S. *Brier Rose*	June 22,	Preston
June 20,	S.S. *Hayle*	June 22,	Preston
June 20,	M.V. *Eurasia*	June 21,	Middleburg
June 20,	S.S. *Groningen*	June 23,	Antwerp
June 21,	S.S. *Dagfrid*	June 27,	Norrkoping
June 22,	S.S. *Reedpool*	June 28,	Los Angeles
June 22,	S.S. *Horn*	June 26,	Pasages
June 24,	S.S. *Rockpool*	June 30,	Portland Me.
June 24,	S.S. *Wild Rose*	June 27,	Weston Point
June 24,	S.V. *Hero*	July 10,	Mersey
June 27,	S.S. *Jarrix*	June 28,	Grimsby
June 28,	S.S. *Evelyn Manor*	June 30,	Aberdeen
June 28,	S.S. *Greta*	June 30,	Gothenburg
June 29,	S.S. *Levenbridge*	July 6,	Boston, Mass.
June 29,	S.S. *Blush Rose*	July 4,	Runcorn
June 29,	S.S. *Mersey*	June 29,	Ridham
June 30,	S.S. *Brier Rose*	July 4,	Leith
June 30,	S.S. *Kentish Coast*	July 4,	Liverpool

Par Harbour Shipping—June, 1928

Arrivals

Date.	Vessel.	From
June 1,	S.S. *Oak*	Blyth
June 5,	S.S. *Evelyn Manor*	Plymouth
June 6,	S.V. *Englishman*	Truro
June 7,	S.V. *Two Sisters*	Mevagissey
June 11,	S.V. *My Lady*	Truro
June 17,	S.S. *Treleigh*	Portreath
June 18,	S.S. *Solway Firth*	Blyth
June 21,	S.V. *Lady Daphne*	Teignmouth
June 21,	M.V. *Welcome*	Plymouth
June 23,	M.V. *Heather Pet*	London
June 23,	S.V. *Alert*	Mevagissey
June 25,	S.V. *Snowflake*	Falmouth
June 26,	S.V. *Kate*	Charlestown

Sailings

Date.	Vessel.	Destination.
June 1,	S.S. *Eastoft*	London
June 2,	S.S. *Treleigh*	Preston
June 3,	S.S. *Oak*	Paimpool
June 4,	M.V. *Isabel*	Plymouth
June 4,	S.V. *Lady Agnes*	Weston Point
June 7,	S.S. *Evelyn Manor*	Plymouth
June 18,	S.V. *Two Sisters*	London
June 16,	S.V. *Englishman*	Weston Point
June 15,	S.V. *My Lady*	Weston Point
June 18,	S.S. *Treleigh*	Preston
June 20,	S.S. *Solway Firth*	Rouen
June 24,	S.V. *Lady Daphne*	Rochester
June 26,	M.V. *HeatherPet*	Charlestown

Charlestown Shipping—June, 1928

Date.	Vessel.	From.	Sailed.	Destination.
May 10,	S.V. *John Simms*	Mersey	June 4,	Mersey
May 28,	S.V. *Katie*	Falmouth	June 4,	London
May 27,	S.V. *Emily Warbrick*	Falmouth	June 4,	London
May 21,	S.V. *Etincelle*	Plymouth	June 5,	Nantes
June 4,	S.S. *Hennie*	Truro	June 6,	Leith
June 5,	S.S. *Knowlgrove*	Truro	June 7,	Sunderland
June 5,	S.V. *Elsa*	Nantes	June 15,	Nantes
June 5,	S.V. *Francis and Jane*	Truro	June 18,	Kirkaldy
June 8,	M.V. *Hans*	Port Talbot	June 15,	Aberdeen
June 13,	M.V. *Rika Annichiena*	London	June 19,	Antwerp (Ground Stone Clay)
June 23,	S.V. *J. Milton*	Falmouth	June 30,	London
June 26,	M.V. *Heather Pet*	Par.	June 28,	Snodland
June 28,	S.S. *Oarsman*	Exmouth	June 30,	Gravesend

Par Harbour Tide Table, August, 1928

(British Summer Time Throughout.)

Day of Week.	Day of Month.	Morning.	Afternoon.	Height.
Wednesday ..	1	6.13	6.34	11.11
Thursday.....	2	6.54	7.14	12.1
Friday	3	7.33	7.51	12.6
Saturday	4	8.9	8.27	12.7
Sunday	5	8.46	9.5	12.7
Monday	6	9.24	9.43	12.5
Tuesday.....	7	10.3	10.24	12.1
Wednesday ..	8	10.46	11.10	11.6
Thursday.....	9	11.36	Nil.	10.11
Friday	10	0.5	0.37	10.6
Saturday	11	1.15	1.57	10.6
Sunday	12	2.40	3.22	10.11
Monday	13	4.1	4.37	11.8
Tuesday.....	14	5.9	5.38	12.4
Wednesday ..	15	6.5	6.29	12.9
Thursday.....	16	6.52	7.14	12.11
Friday	17	7.34	7.53	13.2
Saturday	18	8.11	8.29	13.0
Sunday	19	8.46	9.2	12.8
Monday	20	9.18	9.33	12.2
Tuesday.....	21	9.48	10.3	11.6
Wednesday ..	22	10.19	10.37	10.10
Thursday.....	23	10.57	11.19	10.0
Friday	24	11.45	—	9.4
Saturday	25	0.15	0.50	9.0
Sunday	26	1.30	2.14	9.2
Monday	27	2.59	3.36	9.9
Tuesday.....	28	4.14	4.43	10.8
Wednesday ..	29	5.8	5.31	11.6
Thursday.....	30	5.52	6.13	12.4
Friday	31	6.33	6.53	12.8

E. CLEMENS, Harbour Master.

China Clay Imports for June, 1928

A RETURN showing the quantities and value of China Clay, including China Stone, imported into Great Britain and Northern Ireland as registered in the month of June, 1928, is as follows :—

COUNTRIES WHENCE CONSIGNED.	QUANTITIES. Tons.	VALUE. £
Germany	1	12
U.S. America	1	3
	—	—
Total	2	15

China Clay Exports for June, 1928

A RETURN showing the quantities and values of the exports of China Clay, including Cornish or China stone, the produce of Great Britain and Northern Ireland, from Great Britain and Northern Ireland, as registered in the month of June 1928, is as follows :—

COUNTRY OF DESTINATION.	QUANTITY. Tons.	VALUE. £
Finland	2,020	3,166
Estonia	1,222	1,847
Latvia	308	526
Sweden	3,993	9,083
Norway	890	1,297
Germany	3,114	7,477
Netherlands	3,785	8,266
Belgium	3,595	7,809
France	4,160	7,985
Syria	3	20
Spain	1,665	2,599
Italy	2,738	8,211
Greece	32	173
China	31	151
United States of America	22,662	50,080
Mexico	251	1,019
Peru	20	91
Chile	10	49
Argentine Republic	2	14
Irish Free State	1	6
Protectorate of South-West Africa	1	14
British Iddia, via :—		
Bombay	856	2,821
Bengal, Assam, Bihar and Orissa	102	311
Australia	21	173
Canada	125	749
Total	51,607	113,937

June Deliveries

THE hopes that June would give a fillip to the half-year's volume of business approximating to that of 1927 were not fulfilled, the total turnover being 25,000 tons less than for May, making still larger the adverse balance against this year. This accounts for the shortening of the number of men employed in the industry last month. The only consolation that can be found in the drop is that the first half of this year has suffered from the abnormal demand at the end of last year. The adverse balance against this year is now 61,471 tons, of which 55,700 odd tons are accounted for by China Clay, 3,900 odd by China Stone, and nearly 2,100 by Ball Clay. Details :—

PORT.	CHINA CLAY. Tons. 1928.	Tons. 1927.	CHINA STONE. Tons. 1928.	Tons. 1927.	BALL CLAY. Tons. 1928.	Tons. 1927.	TOTAL. Tons. 1928.	Tons. 1927.
Falmouth	170	1,460	—	—	—	300	170	1,760
Fowey	44,399	66,088	3,026	4,772	2,293	4,241	49,718	75,101
Looe	—	207	—	—	—	—	—	207
Par	2,434	2,517	778	265	—	—	3,132	2,782
Penzance	404	780	—	—	—	—	404	780
Plymouth	1,029	1,650	—	—	—	—	1,029	1,650
Charlestown	3,378	3,135	—	—	—	—	3,378	3,135
By rail	3,721	4,007	—	—	—	—	3,721	4,007
June	55,535	79,884	3,804	5,037	2,293	4,541	61,632	89,422
Total for 5 months	327,523	358,948	21,035	23,740	9,449	8,296	358,007	391,688
Total for 6 months	383,058	438,792	24,839	28,777	11,742	12,837	419,639	481,110

Clay Abstracts

MENTION has already been made in these columns of the *Building Science Abstracts* (containing among other things abstracts of articles on clay) issued by the Department of Scientific and Industrial Research. No. 5 of the series contains a number of abstracts of interest to clayworkers, including "Sand settling and devices for settling and classifying sand," by E. Shaw, the reference being *Rock Prod.*, 1928, **31** (5), 62-4, and **31** (7), 38-40; "Report of second session of committee on sand grading," the reference being *Baunormung*, 1928, **7** (3), 10, suppt. to *Bauing.*, 1928, **9** (14); "The characterisation of clay," by A. F. Joseph, the reference being *Ceram. Soc. Trans.*, 1928, **27** (1), 1; and "Contribution to the study of colloidal clay," by A. Demolon and G. Barbier, the reference being *Annales de la Science agronomique françaises et étrangère*, 1927, **44** 341-373 (*Chem. Abs.*, 1928, **22** (5), 836).

National Federation of Clay Industries

THE National Federation of Clay Industries announces that its address is now Drayton House, Endsleigh Gardens, London, W.C.1.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

London Gazette, &c.

Companies Winding Up Voluntarily

PORCELAIN TILE AND MANTEL CO., LTD.—By reason of its liabilities, June 27. F. R. Boydell, 4, Cedar Street, Blackpool, Certified Accountant, appointed as liquidator.

WHALE BRICK AND TILE CO., LTD.—By reason of its liabilities, June 13. A. Collins, 28, Baldwin Street, Bristol, appointed as liquidator.

Mortgages and Charges

[*NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case, the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.*]

BOOTHS, LTD., Tunstall, earthenware manufacturers.—Registered June 29, series of £5,000 debentures, present issue £3,000; general charge. *£12,475. November 3, 1927.

BROCKET BRICK AND TILE CO., LTD., Nottingham.—Registered May 19, £1,000 debentures; general charge. *Nil. December 5, 1927.

CROWN STAFFORDSHIRE PORCELAIN CO., LTD., Fenton.—Registered June 28, £7,000 (not ex.) mortgage and charge, to Bank; charged on Minerva China Works, Stoke-on-Trent, also general charge. *£3,000. April 13, 1927.

DORSET BRICK STONE AND BALL CLAY CO., LTD., Bournemouth.—Registered June 1, £1,000 debenture to Branch Nominees, Ltd., 15, Bishopsgate E.C.; charged on land at Bournemouth, also general charge.

RICHARDSON (A. G.) AND CO., LTD., Tunstall, earthenware manufacturers.—Registered June 22, £125 mortgage, to Tunstall Golden Hill, Kidsgrove and Talk o'th'Hill, £50 Permanent Benefit Building Society; charged on 4, Victoria Terrace, Tunstall. *£12,500. October 2, 1927.

SOUTH ESSEX BRICK AND TILE CO., LTD., London, W.C.—Registered May 25, £12,000 debentures; general charge.

THYNNE (H. AND G.), LTD., Hereford, tile manufacturers. Registered June 16, £14,000 debenture, to V. H. Pembridge, 6, High Town, Hereford, and another (ranking in priority to £11,800 debentures); general charge. *£27,800. February 11, 1927.

TWENTYWELL BRICK CO., LTD., Dore.—Registered May 24, £1,250 mortgage, to W. E. Straw, The Hundred House, Ruan High Lanes (Cornwall); charged on Twentywell Brickyard, Bradway, Norton (Derby), etc.

WORCESTER ROYAL PORCELAIN CO., LTD.—Registered May 29, £8,000 debentures, balance of £15,000; general charge. *£50,000. April 7, 1928.

Satisfactions

WHITELEY (B. S. AND W.), LTD., Pool (Yorks), paper manufacturers.—Satisfaction registered June 8, £13,300, part of amounts registered September 16 and October 29, 1924.

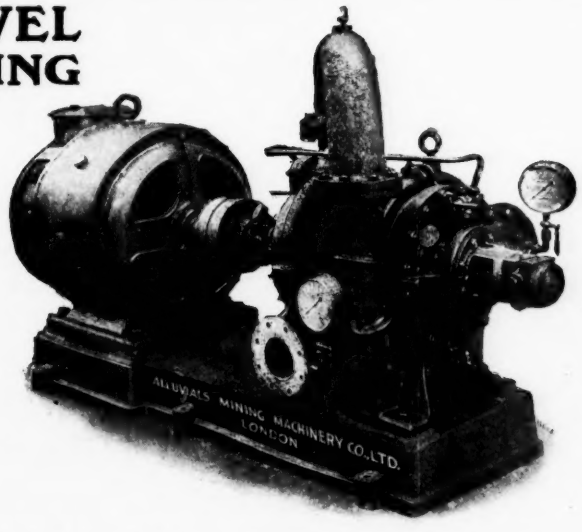
Northern Ontario Fire-Clay Deposits

ACCORDING to the official report of Professor W. S. Dyer, geologist of the Ontario Department of Mines, relative to the deposits of fire-clay and silica sand near the Mattagami and Missinaibi Rivers in the vicinity of James Bay, these are the only deposits of their kind in central Canada. He anticipates that they will soon provide a new source of activity for the industries of the province. The clays are situated within easy access of the new section of the Temiskaming and Northern Ontario Railway line, which is nearing completion. Some of the deposits are suitable for the manufacture of stoneware goods and sewer pipes, and firebrick, while others can be used, if washed, for the manufacture of sanitary porcelains, floor and wall tiles.

The China Clay Trade Review

The Official Organ of the China Clay Industry and the only Journal specially devoted to its interests.

PIONEERS IN GRAVEL AND SAND PUMPING



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AUCTIONEERS.
Hancock & Sons, Sydney Place, St. Austell.

BAGS AND LINERS (COTTON).
Feltham, W. H., & Son, Tower Bridge Road, London, S.E.1.

BANKS.
Barclays Bank, Limited.

CANVAS GOODS.
The N.F. Waterproofing Co., Ltd., Woodside Lane, N. Finchley, N.12.

CHINA CLAY AND CHINA STONE.
Best, Jas., & Sons, Longport, Stoke-on-Trent.
Bloomdale China Clay Co., Ltd., 80, Bishopsgate, E.C.
Burthy China Clay Co., Y.M.C.A. Buildings, St. Austell.
Carbis China Clay & Brick Co., Y.M.C.A. Buildings, St. Austell.
Catalpo, Ltd., London.
Consolidated Mines of Cornwall, 32, Seething Lane, E.C.
Dartmoor China Clay Co., Ltd., 11, Queen Victoria St., E.C.4.
Dyer, Samuel J., Market Hill, St. Austell.
English China Clays, Ltd., St. Austell.
Fox, Roy & Co., Plymouth.
Grose & Stocker, Stoke-on-Trent.
Lovering, J., & Co., St. Austell.
New Halwyn China Clay Co., Y.M.C.A. Buildings, St. Austell.
Newquay China Clay Co., Ltd., Newquay, Cornwall.
North Goonbarrow China Clay, Ltd., 3, Victoria Place, St. Austell.
Parkyn & Peters.
Pochin, H. D., & Co., Manchester.
Somerset Oxide and Ochre Co.
Tehidy Minerals, Ltd., 3, St. Petroc House, Bodmin, Cornwall.
Trethowal China Clay Co., Y.M.C.A. Buildings, St. Austell
United China Clay Co., Ltd., 80, Bishopsgate, E.C.2.
Varcoes China Clays, Ltd., 107, Market Street, Manchester.
West Carclaze China Clay Co., St. Austell.
Wood, T.A.V., Ltd., Grant's Walk, St. Austell.

COALS.
Cornish Mines Supplies Co., Ltd., St. Austell.
Dunkerton Collieries, Dunkerton, near Bath.
H. Rees Jones & Co., Cardiff.
Stockwood, Rees & Co., Ltd.
Welsh Navigation Steam Coal Co., Ltd., Cardiff.

COLLIERIES.
Dunkerton Collieries, Ltd., Dunkerton, near Bath.
Rees Jones & Co., Ltd., Cardiff.

COLOURS AND CHEMICALS.
Brown, R. B., & Co., 45, Finsbury Square, E.C.
Podmore, W. & A. J., Caledonian Mills, Shelton, Stoke-on-Trent.

ELECTRICAL ENGINEERS.
Harry H. Gardam & Co., Ltd., Staines.

ENGINEERS.
Holman Bros., Camborne.
Paulls (Engineers), Ltd., Fowey.
Sidney Smith & Blyth, Ltd., Garratt Lane, Wandsworth, S.W.18.

FILTERPRESS.
Premier Filterpress Co., Finsbury Pavement House, E.C.

GAS ENGINES.
Crossley Bros., Ltd., Manchester.

IRONMONGERS.
Cornish Mines Supplies Co., Ltd., St. Austell.
Stocker, F. E., Ltd., St. Austell.
Hawke & Son, St. Austell.

LAND & MINE SURVEYORS.
Trythall & Champion, Camborne.

LUBRICANTS.
Cornish Mines Supply Co., Ltd., St. Austell
Reliance Lubricating Oil Co., Ltd., 19–20, Water Lane, E.C.
Willcox, W. H., & Co., Ltd., 32–38, Southwark Street, London, S.E.1.

MINING ENGINEERS.
Rich, Wm., & Sons, Redruth.

MINING MACHINERY.
Alluvials Mining Machinery Co., 2, Broad Street Place, E.C.
Cornish Mines Supplies Co., Ltd., St. Austell.
Hadfields, Ltd., East Hecla Works, Tinsley, Sheffield.
Rich, Wm., & Sons, Redruth, Cornwall.

MINING SUPPLIES.
Cornish Mines Supply Co., Ltd., St. Austell.
Hadfields, Ltd., East Hecla Works, Tinsley, Sheffield.
Holman Bros., Camborne.
Rich, Wm., & Sons, Redruth, Cornwall.

MOTOR TRANSPORT.
Mid-Cornwall Transport Co., Ltd. (1922), Bodmin Road, St. Austell.

PIPES.
British Mannesmann Tube Co., Ltd., Salisbury House, London Wall, E.C.2.
Ryland, A., Cradley Heath, Staffs.

PUMPS.
Alluvials Mining Machinery Co., 2, Broad Street Place, E.C.
Cornish Mines Supplies Co., Ltd., St. Austell.
Willcox, W. H., & Co., Ltd., 32–38, Southwark Street, London, S.E.1.

QUARRYING AND MINING REQUISITES.
Cornish Mines Supplies Co., Ltd., St. Austell.
Hadfields, Ltd., East Hecla Works, Tinsley, Sheffield.
Rich, Wm., & Sons, Redruth, Cornwall.
Warden, F. H., Ltd., Birmingham.

RAILS (Bridge, Flange, Double or Bullhead).
Bute Works Supply Co., Ltd., 53, Cymric Buildings, Cardiff.

RAILWAY WAGONS.
Bute Works Supply Co., Ltd., 53, Cymric Buildings, Cardiff.
Roberts, Charles, & Co., Ltd., Horbury Junction, nr. Wakefield.

ROPES.
Cornish Mines Supplies Co., Ltd., St. Austell.

SHIPBROKERS.
Blake, G. A., 11, High Cross Street, St. Austell.
Ludlow & Sons, Penzance.
Simpson, Spence & Young, London.
Toyne, Carter & Co., Fowey.

SACKS & BAGS.
Andrew Weir & Co., 21, Parliament Street, Liverpool.
Boag, Thos., & Co., Ltd., Greenock.
Cornish Mines Supplies Co., Ltd., St. Austell.
Dovener, J. H., & Co., Union Street, Liverpool.
North Mills Co., Ltd., Little Peter Street, Manchester.
The N.F. Waterproofing Co., Ltd., Woodside Lane, N. Finchley, N.12.

TIMBER IMPORTERS.
Cornish Mines Supplies Co., Ltd., St. Austell.
Fox, Eliott & Co., Plymouth.
T. Warne, St. Austell.

WATERPROOFING.
The N.F. Waterproofing Co., Ltd., Woodside Lane, N. Finchley, N.12.

WIRE ROPES.
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The China Clay Trade Review

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China Clay Industry Developments

THE announcement of the negotiations that are afoot for the acquisition of Messrs. John Lovering and Co.'s China Clay and Stone business, is yet another indication of the changes that are taking place in the control of China Clay production.

Since the war, there has been a gradual lessening of the number of separate firms engaged in the industry, the forerunner of the amalgamations having been the union of the forces of the West of England China Clay Co., Messrs. Martin Brothers and the North Cornwall China Clay Co. into what is now known as English China Clays, Ltd. Then followed closely the acquisition by Messrs. H. D. Pochin and Co., Ltd., of Messrs. John Higman and Co.'s works, bringing them into the position of being the third largest producers. Last year saw the amalgamation of North Goonbarrow and Halviggan with English China Clays, Ltd., followed by the purchase of Anchor United and Melangoose China Clay Cos. by the Paper Makers Importing Co. of America, who have had a buying organization in St. Austell for many years. Early this year saw a further absorption by English China Clays, Ltd., of Rosevear China Clays, Ltd. and the Imperial China Clay Co., Ltd.

Still Several Producing Firms

With all these absorptions, there are still many individual producing firms, of whom Messrs. Parkyn and Peters, Messrs. Grose and Stocker, and Varcoes China Clays, Ltd. are among the oldest and biggest, but the bulk of the producing business is in the hands of the three firms represented by English China Clays, Ltd., Messrs. John Lovering and Co., and Messrs. Pochin and Co., and they have under their control by far the greater proportion of best clays, which are the winning counters in the China Clay business, because they are the most immune from foreign competition.

Capitalisation Ideal

The reported intervention of Sir Charles Cottier as the chief in the financial operation in connection with the Lovering negotiations, has led to a renewal of talk in China Clay circles of the possibilities of developments on a large scale in the direction of the capitalisation of the whole industry as one concern. For all practical purposes on the sales side, the industry is now organised as one concern through the Association which controls all but a small fraction of the total output of the producing firms, though all of them retain liberty of action as regards production and management. Many advocates of the Association plan have long since looked upon the capitalisation of the whole industry as the ultimate aim, on account of the greater strength it would give the industry in dealing with foreign competition.

Meeting Foreign Competition Menace

It is argued that the bringing of all concerns now engaged in the industry into one great combination, would give a great impetus to the development of overseas markets, because, as a result of the saving and economising that would follow upon the elimination of competition between individual producers, effort could be concentrated upon the cultivation and development of markets. During the war, great encouragement was given to the development of foreign kaolins through the interruption of supplies of home China Clays, and since then the deposits then opened up have come into increased production. This increased production has been coming more and more into competition with our clays in foreign markets, and unless our home producers can do something to meet it by the price factor, it may become even more formidable than it is.

Amalgamation Possibilities

The question that has to be faced sooner or later is: How can the industry be best organized to make it powerful and resourceful enough, not only to maintain its hold upon foreign markets, but to enlarge it? The answer seems to be amalgamation. Other industries, more powerful than the China Clay industry, have proved the benefits of amalgamation as an essential move in the economic offensive.

It is sometimes forgotten that China Clay production is essentially a British industry, the possibilities of China Clay as a valuable raw material in industry having been first proved by the pioneers in Cornwall and Devon, and developed by them. Those who have entered the field since, have traded upon the pioneer work of our home producers, who were the first to exploit the overseas markets which are now being threatened more and more, following upon the disadvantage in which home producers were placed through the war. If, by a combination of interests, production costs could be substantially reduced, our overseas markets could not only be recovered, but considerably increased. Thus would the volume of production become greater and the provision of employment be maintained at a much higher level than now.

Events will show to what extent the amalgamation idea is likely to develop. The gradual accretion of strength by the Big Three may possibly hasten it and make it easier of accomplishment.

The Board of Trade Returns

The Board of Trade Returns for July indicate that during that month exports of China Clay, including Cornish or China Stone, amounted to 41,284 tons (valued at £91,922), as compared with 45,139 tons (valued at £93,667) in July, 1927, and 80,649 tons (valued at £167,272) in July, 1926. For the seven months ended July 31, 1928, exports amounted to 336,586 tons (valued at £744,953), as compared with 371,888 tons (valued at £786,923) in 1927 and 397,807 tons (valued at £824,500) in 1926. If fireclay and all other sorts of clay be also added to the account, the value of clay exports in July was £108,737 (as compared with £111,268 in 1927 and £190,306 in 1926); while for the seven months ended July 31, 1928, exports were valued at £882,379 (as compared with £932,832 in 1927 and £996,702 in 1926).

China Clay Deal

Reported Acquisition of Lovering and Co.'s Works

It is reported that the negotiations that have been going on for some time for the acquisition of John Lovering and Co.'s China Clay and Stone business in Cornwall, are being completed, and that the purchase price is well over half a million pounds.

The principal in the deal is Sir Charles Cottier, the Plymouth solicitor, who, before the war, left the West Country, and became one of the big men in the financial world of London. He has at his command great financial resources, which, with his financial co-operators, he has used in the development of some big companies whose shares are always active on the London Stock Exchange. His active interest in the China Clay industry has so far been confined to Hensbarrow China Clays, Ltd., in which he has the controlling interest, and which is under the management of his son, Mr. C. M. Cottier, and Mr. John Morton.

History and Development of Loverings

John Lovering and Co.'s works include among them some producing the best clays of the market. For some time, owing to a breakdown in health, Mr. John Lovering, the senior partner, has not taken such an active interest in the business as formerly, but his brother, Mr. W. T. Lovering, who has been chiefly concerned in the management of the works, and his elder son, Mr. J. S. Lovering, who has had charge of the office organisation, are still actively engaged in the business. Latterly Mr. Reginald Lovering has assisted his father, Mr. W. T. Lovering.

Lovering's is one of the pioneer producing firms in the China Clay industry, and has world-wide connectons. Up to now it has always been a family business. The Martins and Loverings, who founded the business over 100 years ago, have continuously, through their successors, developed and carried on the business, becoming the second largest (English China Clays being the biggest) producers in the industry, with an output of about 180,000 tons per annum. The bulk of their works are in the St. Austell parish, in the neighbourhood of Carthew and Stenalees. It is understood that the present principals will continue to assist in the management of the works under the new regime, and that there will be no material change on the production side.

The works operated by Lovering and Co. include the following: Carclaze, Cleaves, Higher and Lower Ninestones, Penhale, Carbean, Meledor and Wheal Arthur in the St. Stephens district; Wheal Grey and Bakers in the Penzance district; stone quarries at St. Dennis; as well as cooperages, blacksmiths' and carpenters' shops and equipment depots.

Lovering and Co. are members of Associated China Clays, Ltd. (the producers Association), but the acquisition of the business by Sir Charles Cottier and his friends will make no difference to their membership, which is provided for under the terms of the Association's articles. Hensbarrow China Clays, Ltd., are already members of the Association.

It is thought in China Clay circles that this new movement in the financial control of the industry may lead in course of time to wider developments.

Tug Company's Claim for Salvage

Important Case in Court

A case of importance to the owners of vessels engaged in the China Clay carrying trade was decided at the last St. Austell County Court, when His Honour Judge Gurdon gave judgment upon the case heard at the Truro County Court in which the Fowey Tug and Salvage Co. sued the master of the auxiliary schooner *Romanie* for £50 in respect of salvage services rendered on December 18 last by the tug *Cruden Bay*.

The sum originally claimed was £20, and His Honour related the circumstances which led to the action. On December 18, 1927, the *Romanie* came into Par Bay on her way to Charlestown and dropped anchor. A gale of wind was blowing, and the vessel began to drag her anchor. The D.Y.P. signal had been hoisted on board the schooner on the morning of December 18, and at 9 a.m. the Board of Trade Officer near Apple Tree, Charlestown, notified the tug company, who sent the tugs *Cruden Bay* and *Gallant* to the schooner. Meanwhile the anchors of the schooner had held in the rock, though the wind was still blowing strongly. When the tugs arrived, some conversation ensued between the captains of the schooner and the *Cruden Bay*, in which the captain of the schooner asked the tug captain what he had come there for, and the latter replied that he had come as a result of the notification received following the hoisting of the signal, which was apparently still flying. Subsequently the captain of the *Romanie* asked what the captain of the tug would charge to tow him to the shelter of the Gribben Head Cliffs. The captain of the tug named a sum which was not accepted.

Commenting on the statements as to the conversation, His Honour said he was of opinion that conversation must have been very difficult, and he believed that what the captain of the *Romanie* asked for was not to be towed to safety, but to be towed to shelter. Later the tugs went away, and when the wind abated the schooner proceeded to Charlestown.

His Honour said he had to determine what the true position of the *Romanie* was when she hoisted the D.Y.P. signal on the morning of December 18, 1927. It was an ambigous signal in the circumstances, exhibited with a view to obtaining the assistance of the tug with the object of towing the *Romanie* across the bay to the shelter of the Gribben shore. His opinion was that she was in a dangerous position, and her captain, realising this, exhibited the position signal. If he was, in fact, at the time in question, in actual danger, or in a position where danger might reasonably be apprehended, the tug was entitled to be rewarded on coming to the vessel's assistance. He awarded the plaintiffs £20 for such services and gave judgment with costs.

Rod and Ball Mill Crushing

A Recent Investigation

For some months, the Intermountain Experiment Station of the United States Bureau of Mines, at Salt Lake City, Utah, in co-operation with the United States Smelting, Refining and Mining Co., has been conducting a study of the influence of certain factors on rod and ball mill crushing. The factors involved in this study are: rate of feed, thickness of pulp, and ball load. In making this study a series of samples were obtained from one grinding unit at the Midvale plant of the company. This unit consists of a 5-ft. by 10-ft. primary rod mill and a 5-ft. by 10-ft. secondary ball mill, each in closed circuit with an Akins classifier.

The primary object of the grinding investigation at Midvale is to obtain as complete information as possible on the minus 200-mesh material present throughout the grinding circuit. For this purpose the minus 200-mesh from each sample is separated into four sizes by elutriation. These four sizes are compared with similar products obtained by the elutriation of minus 200-mesh quartz, the surface of which has been determined. By allowing for difference in settling rate for the various minerals, and also for their difference in shapes, it is thought that a fairly accurate surface measurement of the various products will be obtained. The samples were taken for a definite period of time from the entire stream of pulp, tonnage figures were obtained, and from the sizing tests and the elutriations tonnage, balances of the various sizes were also obtained. All of the samples, as well as the various sizes, have been analysed. From the data thus obtained the distribution of the various minerals is being determined, and the amount of surface represented in the various products is being calculated. These surface figures are to be used in ascertaining the power efficiency for the two mills, power readings having been taken during the sampling period.

A figure of "useless work," in material finer than that required, will also be obtained for the two mills. As the calculations involved in obtaining this information, while very simple, require considerable time, they have not yet been completed. A second series of samples has been taken, under normal operating conditions, extending over a longer period of time than for the first samples. This second series is in the nature of a check on the first, this being very desirable in connection with the result obtained in elutriation. Should this study indicate that certain changes in the grinding operation would be beneficial, it is proposed to make such changes for the purpose of further investigation.

Cimita Ceramic: A New Variety of Clay

A Report from Chile

In a recent report from the Technical Chemical Laboratory of the Corps of Mining Engineers of Chile, reference is made to a specimen, received for examination, which was described as a rock containing soapstone, owing to its unctuous surface. All its characteristics, however, clearly proved that this idea was without foundation, so that further examination was made.

As it was evident from the unctuous nature of the rock that it contained clay in a finely divided state, a preliminary analysis was made by the Seger method which gave 60 per cent. of clay. Analysis of the residue, after extraction of the clay, demonstrated that it was question of a rather pure felspar, seeing that there were only rare grains of quartz. This preliminary examination led to the conclusion that the specimen in question was really a natural clay mixture which might be successfully utilised for the manufacture of industrial products, and the final analysis, states the report, proved that this was the case. As, however, the specimen was very small, nothing was left of it and some considerable time was spent in obtaining a larger quantity and more reliable information concerning the deposit.

In this emergency Señor Salcedo came to the aid of the laboratory, as he was acquainted with the mineral, its origin and the deposit from which it came in the province of Coquimbo, where it exists in enormous quantities. The new supply was large enough to continue the work commenced, and nine analyses were made with special attention to those parts which appeared different to the eye. There would be no point in giving all the details of the work, though it was of great value for guidance in the laboratory, but the following is a brief account of the general composition of the substance which truly represents the average of results.

The non-plastic part, usually called free silica, consisting chiefly, in this case, of felspar, represented 41.35 per cent., as follows, of the total :

Combined Silica	27.67 per cent.
Alumina	13.31 ,, ,,
Potassium Oxide	0.22 ,, ,,
Sodium Oxide	0.15 ,, ,,

The plastic part or clay completed the 100 per cent., as follows :—

Silica	26.45 per cent.
Alumina	21.95 ,, ,,
Iron Oxide	0.40 ,, ,,
Lime	0.16 ,, ,,
Magnesia	traces
Titanium Oxide	0.31 ,, ,,
Fluorine	traces
Potassium Oxide	3.52 ,, ,,
Sodium Oxide	0.20 ,, ,,
Combined Water	5.0 ,, ,,
Hygroscopic Water	0.30 ,, ,,

Properties of the Clay

All the work brought to light the peculiar properties of this natural product and it was made clear that it could be directly utilised for industrial purposes. It also appeared that the mixture of clay and felspar was so close as to suggest the possibility of dispensing with extremely fine grinding in practical work, which would be a great advantage. In the manufacture of ceramic pastes, grinding to an impalpable powder is essential for absorption of the melted felspar by the clay, which gives the final paste. This fine grinding, a long and expensive operation, is not necessary in this case, as the natural product is said to have a homogeneity which could not be equalled with ordinary methods of work. The small percentage of iron and titanium in this product, is a sure sign that the pastes would be of very nearly perfect white colour.

Any clay deposit may occasionally contain this product combined with other substances in such proportions as to make it of use for ceramic pastes without artificial changes in the composition. But this is exceptional and very difficult to obtain in practice. On the other hand, trituration of such a mixture could not be dispensed with whatever the exterior aspect of the mass, considering that the formation of clays at the expense of rocks containing felspar is a phenomenon which excludes all possibility of perfect pulverisation of the other constituents of the mother rock. In the case dealt with this phenomenon of intermixing is normal because the felspar has been kaolinised in a very diffused form in all the mother rock.

Claims Made for the Clay

Thus it is question of a specific characteristic of this rock, which, together with the peculiar feature of the transformation in the exact degree to constitute a directly utilisable ceramic material, is claimed to distinguish it from others hitherto existing. Taking all this into consideration, it has been decided to give this clay a special name, and the writer of the report, Jorje Westman, has adopted the word " Cimita," the first three letters being the initials of the official name of the Corps of Mining Engineers, with the current termination of mineralogical nomenclature.

Results obtained in practical applications are claimed to have exceeded the most optimistic theoretical expectations. The product from fired " Cimita " is a very hard, firm, stoneware, with a very fine grain and perfectly vitrified texture. The white colour is almost pure and the substance quite impermeable. Its appearance is claimed to be very much finer than that of the most highly-prized products in the markets. Firing in the laboratory varied from 3 to 3½ hours with hot fire. It is impossible to give the precise temperature of firing owing to the absence of instruments in the laboratory, though it can be estimated at about 1000° C.

No doubt it will not be possible to work so quickly and easily with industrial firing, but it is asserted that in any case firing will be very much quicker and easier than with most other known materials. After repeated trials, the following enamels were selected for this ware.

Frit for White Opaque Enamel.	
Orthose felspar	58 parts
Boric acid	20 ,,
Litharge	10 ,,
Chalk	16 ,,
Tin oxide	12 ,,
Frit for Green Opaque Enamel.	
Felspar	58 parts
Lead bichromate	16 ,,
Chalk	16 ,,
Boric acid	20 ,,

These enamels or any others must necessarily have a lead base, as successful results cannot be expected with purely felspathic enamels for a low temperature and quick firing. The plasticity of " Cimita " is inferior to that of current clays and it is thought that a workman accustomed to the latter will find difficulties with the new product. This, however, is merely comparative, and the report claims that there can be no difficulty in training skilled workers for " Cimita." On the other hand, suitable ceramic materials can be mixed with " Cimita " In the case of a thinning material being required for work in the press or the same with slips it may be well to utilise the same " Cimita " previously biscuit fired, which is easily done at a temperature of about 600° C. The author of the report considers that " Cimita " is admirably suitable for work with slips.

The ceramic industry is not in itself so complicated as are the preparation and production of the necessary materials. It is this which makes it difficult and expensive. This, perhaps (states the report) is why the industry has not been developed in countries where conditions are not particularly favourable. All difficulties and tiresome stages in manufacture are claimed to be eliminated by utilisation of " Cimita," as all work is reduced to a minimum. This is the essential feature in the employment of the new material. Heavy ware, the most important, commercially speaking, and the most lucrative, such as baths, lavatories, etc., can be made from " Cimita " with great speed, perfection and rapidity. (*Boletin de la Sociedad de Fomento Fabril*).

China Clay Notes and News

China Clay Rating Relief Assured

In the course of a speech given by Sir Charles Kingsley Wood, Parliamentary Secretary to the Ministry of Health, at Tregrehan, near St. Austell, on July 21, the de-rating proposals of the Government in their bearing on the China Clay industry were referred to in the following reassuring terms: About a millions tons of China Clay were produced every year, and the industry itself estimated that its rates amounted approximately to 2s. 6d. on every ton produced. The rates levied on Cornish mines, quarries, and factories in 1928 were £105,000 out of approximately one million pounds levied on the total population of 315,000. Agriculture paid in rates in Cornwall in 1927 and 1928, £108,000. The Government were going to relieve agriculture by a total remission of its rates, and were going to remit three-quarters of the rates on productive industries. The tin-mining and China Clay industries would benefit by the Government's scheme in the same way as other productive industries.

Mr. Pilcher's recent statement had cleared up any doubt as to the position of the China Clay industry, and he (Sir Kingsley Wood) would reassure anyone that there was no doubt whatever that that industry would share to the full any benefit of the relief the Government was affording. He suggested that they were right in giving relief to the productive industries, whether prosperous or unprosperous, and if they looked at the matter from the point of view of unemployment there was no harm, in fact nothing but good, in helping the prosperous to become more prosperous and to employ more men. So far as the householder and the distributive trades were concerned the best way to help every man and woman, especially the industrial worker, was to reduce unemployment and to get the wheels of industry going again. Not a penny of the cost of this relief was going to fall on the ratepayers.

G.W.R. Traffic Facilities Criticism

At the last meeting of St. Austell Urban Council, Councillor Mules said he had been requested to bring up a matter which was really a concern of that Council indirectly, and that was with regard to the traffic facilities at the railway station.

Recently 18 teams of horses waited two, three and four hours at the station because there were no trucks to put the clay into. A town like St. Austell ought to have better conditions than that. He would like a representation to be made to the company from the Council. Such a state of things was not fair to the trading people of the area. It was a very serious matter. Councillor Hoskin seconded.

The Council agreed to the proposal to communicate with the railway company.

Technical Exhibition at St. Austell

The Royal Cornwall Polytechnic Society's Exhibition, held in St. Austell for five days, was the first to be held in the chief town of the China Clay industry, and so far as number of exhibits went it was the best the society has held. The local committee (with Mr. P. D. Vowles as secretary), the councils, and the education authorities worked hard in conjunction with the Society's secretary, Mr. E. W. Newton, of Camborne, and the result was an exhibition which it was worth everyone's while to visit.

China Clay production was featured in the exhibition to some extent, though there was a lack of examples of the various uses to which the clay and stone are put. The chief feature was a well-constructed model of a China Clay works and dry, with all the various pumping processes depicted, including the pumping and washing out of the clay from the side of the pit by means of hydrants. Electricity was used to drive the model plant. This exhibit was supplied by Mr. R. W. Varcoe, of Varcoe's China Clays, Ltd., who also had a stand in another part of the exhibition, showing blocks of refined and dried clay, various kinds of China Stone, clay in semi-liquid condition, and decomposed clay bearing stone.

English China Clays, Ltd., had a stand with photographs of various works and examples of clay and stone in various forms and China Clay brick. Mr. J. M. Coon, who is a well-known scientific authority on China Clay, showed examples of microscopic work and apparatus used in the testing of clay.

An exhibit worthy of special note was the model of a China Clay works made (largely in cardboard) by the scholars of the Treverbyn Council School, where the average age is only 12½ years.

A Fine Effort

Mr. E. W. Newton, the secretary, at the opening ceremony said that they had there what he thought—when it was thoroughly considered and digested—was one of the best exhibitions they had ever held. This was not so much in the multiplicity of its trade exhibits, which were practically a thing of the past. He believed their society was the first association that ever held an engineering exhibition. It had been copied by many other agencies, and except in very large towns it was very difficult to hold a trade exhibition in Cornwall. Yet they ought to be pleased that although they had not many trade exhibits those that they had were well worthy of a position in the Exhibition. They had the products of three Cornish firms who had been in existence for considerably over 100 years. They were Holman Bros., of Camborne, Messrs. Bickford-Smith, manufacturers of the safety fuse (now a part of Imperial Chemical Industries, Ltd.) and John Stephens and Sons, Ltd., of Falmouth (British Ropes, Ltd.).

They had in that locality millions of tons of waste material, and now some use was being made of it. They would see an exhibit of concrete blocks by the Pentewan Dock and Concrete Co. He understood that the concrete blocks made from the waste sand of China Clay working proved better than any other making. If so, he congratulated them, because they had enough sand for posterity in their heaps, and it would improve the landscape if some use could be made of it. There were also some bowls made from the same material. The China Clay exhibits were not numerous, but there were two from representative firms, English China Clays, Ltd., and Varcoe's China Clays, Ltd. They were very instructive and educational.

Among the awards were the following: Nobel's Explosives, Ltd., diploma of honour for stand and first bronze medal for safety igniters, etc.; R. W. Varcoe, working model of a China Clay mine, second silver medal; Varcoe's China Clays, Ltd., diploma of honour; English China Clays, Ltd., diploma of honour; Pentewan Dock and Concrete Co., Ltd., first bronze medal.

Clay Droppings Nuisance

The highways committee of the St. Austell Urban Council recommended at the last meeting that the attention of the clay carriers be drawn by mean of posters and circulars to the damage caused to the tarred roads by the dropping of clay from their wagons. Speaking to the recommendation, Councillor R. M. Richards said that the reports in the papers had had some effect already. The recommendation was carried.

Unemployment Figures

The following figures show the unemployment position in Mid and West Cornwall at present:—Redruth, 629; Camborne, 304; Falmouth, 419; Fowey, 115; Hayle, 195; Helston, 41; Newquay, 24; Penzance, 278; Perranporth, 22; St. Austell, 390; St. Columb, 53; St. Just, 89; Truro, 158. Of this total, 263 men, 84 women, and 15 girls are stood off temporarily or are in casual employment.

New Company

Ceramic Trust, Ltd., was registered as a private company on July 23, with a nominal capital of £60,000 in 50,000 10 per cent. cumulative preference shares of £1 each and 200,000 ordinary shares of 1s. each. The objects are: To acquire and hold shares, stock, debentures, debenture stock, bonds, notes and any other securities; to carry on banking business; to discount bills, and act as company secretaries; to carry on the business of manufacturers of and dealers in fire-bricks, furnace and other linings, bricks, tiles, pipes, pottery, earthenware, china, terra cotta, ceramic and enamelled ware, sanitary appliances, etc. The first directors (to number not less than two nor more than eight) are to be appointed. Qualification, 1,000 shares; remuneration, £200 each per annum. Solicitors, Brown, Turner, Compton Carr and Co., 3–4, Clements Inn, London, W.C.2. Registered office, 65, London Wall, E.C.2. File number, 232,207.

Shipping and Export News of the Month

We give herewith latest particulars relating to arrivals and sailings of ships engaged in the China Clay trade, at the principal British clay ports. Registered exports of China Clay, with countries of destination, and other shipping and export matters are dealt with.

Fowey Shipping—July, 1928

Arrived.	Name.	Sailed.	Destination.
July 1,	S.S. *Cornish Merchant*	July 3,	Northfleet
July 1,	S.S. *Marta*	July 2,	Gothenburg
July 2,	S.S. *Cisneros*	July 3,	Genoa
July 2,	S.S. *Horn*	July 6,	Bilbao
July 3,	S.S. *Phacacian*	July 7,	Terneuzen
July 3,	S.S. *Cornish Trader*	July 7,	Rouen
July 4,	S.S. *Guelder Rose*	July 7,	Grangemouth
July 4,	S.S. *Mersey*	July 6,	Runcorn
July 4,	M.V. *Vesta*	July 6,	Sornashamm
July 4,	S.S. *Gronant Rose*	July 6,	Preston
July 5,	S.S. *Wearbridge*	July 11,	Philadelphia
July 5,	S.S. *Gouwestroom*	July 10,	Amsterdam
July 5,	S.S. *Hayle*	July 7,	Manchester
July 6,	S.S. *Mons*	July 11,	Ghent
July 7,	S.S. *System*	July 11,	Hull
July 8,	S.S. *Tynebridge*	July 17,	Portland, Me.
July 9,	S.S. *Foch Rose*	July 12,	Brussels
July 9,	M.V. *Karnten*	July 12,	Granton
July 9,	S.S. *Marta*	July 10,	Hamburg
July 9,	S.S. *Goodig*	July 12,	Antwerp
July 10,	S.S. *Emingdring*	July 14,	Noorkoping
July 11,	M.V. *Mayals*	July 17,	Weston Pt.
July 12,	S.S. *Wild Rose*	July 13,	Weston Pt.
July 12,	S.S. *Jarrix*	July 14,	Terneuzen
July 12,	S.S. *Kis*	July 18,	Halden
July 13,	S.S. *Primrose*	July 16,	Runcorn
July 13,	S.S. *Scheldejol*	July 14,	Gravelines
July 13,	S.S. *Ribblebank*	July 17,	Liverpool
July 13,	S.S. *Blush Rose*	July 17,	Larne and Preston
July 14,	S.S. *Mersey*	July 17,	Ridham
July 14,	M.V. *Mogens Koch*	July 18,	Harburg
July 14,	S.S. *Horn*	July 14,	La Pallice
July 14,	S.S. *Wilhelm*	July 18,	Riga
July 15,	S.S. *Sturdee Rose*	July 19,	Weston Pt.
July 15,	S.S. *Eskwood*	July 20,	Antwerp
July 15,	M.S. *Pinto*	July 18,	Genoa
July 16,	M.V. *Shamrock*	July 17,	Plymouth
July 17,	S.S. *Cristina*	July 21,	Genoa
July 18,	S.S. *Westdale*	July 21,	Leith
July 18,	S.S. *Seaforth*	July 20,	Terneuzen
July 18,	S.S. *Pansy*	July 18,	Bo'ness
July 19,	M.S. *Sande*	July 24,	Skien
July 19,	S.S. *Indra*	July 24,	Kotka
July 20,	M.V. *Jantje, R.*	July 25,	Stettin
July 20,	M.V. *Lydia Cardell*	July 28,	Rouen
July 21,	S.S. *Lieutenant le Mornier*	July 24,	La Pallice
July 21,	S.S. *Horn*	July 24,	Leith
July 21,	S.S. *Regina*	July 25,	Terneuzen
July 22,	S.S. *Baltic*	July 25,	Sheboygan, U.S.A.
July 22,	S.S. *Gouwestroom*	July 26,	Amsterdam
July 22,	S.S. *Wild Rose*	July 25,	Preston
July 23,	S.S. *Gronant Rose*	July 26,	Brussels
July 23,	S.S. *Seemoos*	July 26,	Harburg
July 23,	S.S. *Robrix*	July 27,	Gravesend
July 23,	S.S. *Diamond*	July 27,	Antwerp
July 23,	S.V. *Vera*	July 27,	Raumo
July 24,	S.S. *Olivine*	July 28,	Antwerp
July 25,	S.S. *Primrose*	July 27,	Barrow
July 25,	S.V. *Najaden*	*	Charlestown
July 26,	M.V. *Grete*	July 27,	Karlskrona
July 26,	S.S. *Edna*	July 30,	Liverpool
July 26,	S.V. *Mary Ann*	*	Runcorn
July 27,	S.S. *Hayle*	Aug. 1,	Garston
July 27,	S.S. *Glencregagh*	July 28,	Rouen
July 27,	S.V. *Waterwitch*	Aug. 9,	
July 27,	M.V. *Conrad Luhring*	July 30,	Wiborg
July 28,	S.S. *Blush Rose*	July 31,	Runcorn
July 28,	M.V. *Isabel*	July 29,	Par.
July 28,	S.V. *Duchess*	Aug. 2,	Runcorn
July 28,	M.V. *Oceaan*	Aug. 1,	Oscarsham
July 29,	S.S. *Sedgpool*	Aug. 9,	New York
July 30,	S.S. *Florentino*	July 31,	Genoa
July 31,	S.S. *Mersey*	Aug. 3,	Ridham
July 31,	S.S. *Eskbridge*	Aug. 2,	Portland, Me.

* Signifies "In Port."

Par Harbour Shipping—July, 1928

Arrivals

Date.	Vessel.	From
July 1	S.S. *Camm*	Blyth
July 2	M.V. *Isabel*	Falmouth
July 3	S.S. *Kyle Firth*	London
July 3	S.S. *Condor*	Torquay
July 3	S.S. *Treleigh*	Charlestown
July 3	S.S. *Norrix*	Penryn
July 4	S.S. *Trader*	Exmouth
July 14	S.S. *Grosvenor*	Poole
July 15	M.V. *Camborne*	Falmouth
July 17	S.S. *Austin Gough*	Plymouth
July 18	M.V. *Isabel*	Truro
July 19	S.V. *Triumph*	Truro
July 19	S.V. *P. H. E.*	Penryn
July 21	S.S. *Camm*	Hayle
July 21	S.V. *Mary Barrow*	Penzance
July 24	S.V. *Emily Warbrick*	Plymouth
July 24	S.S. *York Valley*	Teignmouth
July 26	S.S. *Enterpriser*	Teignmouth
July 26	S.V. *Clymping*	Charlestown
July 27	S.S. *My Lady*	Polperro
July 29	S.V. *Englishman*	Truro
July 28	S.V. *Isabel*	Truro
July 31	S.S. *Beaconray*	Goole

Sailings

Date.	Vessel.	Destination.
July 2	S.S. *Camm*	Roscoff
July 4	S.S. *Norrix*	Gravesend
July 5	S.S. *Kyle Firth*	Cork
July 5	S.S. *Treleigh*	Preston
July 6	M.V. *Isabel*	Plymouth
July 6	S.S. *Trader*	Gravesend
July 7	M.V. *Welcome*	Gloucester
July 7	S.S. *Condor*	Ternuezen
July 16	S.S. *Grosvenor*	Rochester
July 19	M.V. *Isabel*	Plymouth
July 19	S.V. *Triumph*	Plymouth
July 19	S.V. *P. H. E.*	Plymouth
July 20	S.S. *Austin Gough*	Antwerp
July 23	S.S. *Camm*	London
July 26	S.S. *York Valley*	Jersey
July 28	S.S. *Enterpriser*	Queenboro'

Charlestown Shipping—July, 1928

Date.	Vessel.	From.	Sailed.	Destination.
June 16,	S.V. *Pet*	Glasgow	July 4,	Garston
June 30,	S.V. *Flying Foam*	Mevagissey	July 5,	London
July 4,	S.V. *Gaelic*	Ayr	July 17,	Runcorn
July 4,	S.S. *Knowlgrove*	Kingsbridge	July 6,	Tayport
July 4,	S.V. *Vonette*	Painpol	July 16,	Nantes
July 6,	S.S. *Beaconray*	Shoreham	July 7,	London
July 10,	M.V. *Katie*	Falmouth	July 14,	London
July 10,	S.V. *Lady Agnes*	Pentewan	July 15,	Goole
July 12,	S.V. *Lady Jean*	Pentewan	July 16,	Rochester
July 18,	S.S. *Grit*	Torquay	July 19,	London
July 20,	S.V. *Lady Rosebery*	Truro	July 25,	Rochester

Par Harbour Tide Table, September, 1928

(British Summer Time Throughout)

Day of Week.	Day of Month.	Morning.	Afternoon.	Height.
Saturday	1	7.12	7.31	13.2
Sunday	2	7.49	8.6	13.6
Monday	3	8.24	8.42	13.6
Tuesday	4	9.1	9.20	13.2
Wednesday	5	9.39	9.59	12.7
Thursday	6	10.20	10.43	11.9
Friday	7	11.9	11.39	10.9
Saturday	8	—	0.15	10.0
Sunday	9	0.58	1.48	9.11
Monday	10	2.37	3.28	10.6
Tuesday	11	4.2	4.36	11.5
Wednesday	12	5.5	5.30	12.3
Thursday	13	5.53	6.14	12.9
Friday	14	6.34	6.53	13.0
Saturday	15	7.11	7.27	13.3
Sunday	16	7.42	7.57	14.2
Monday	17	8.12	8.27	12.10
Tuesday	18	8.41	8.55	12.4

Day of Week.	Day of Month.	Morning.	Afternoon.	Height.
Wednesday	19	9.9	9.23	11.9
Thursday..	20	9.38	9.54	10.11
Friday ...	21	10.12	10.33	10.1
Saturday .	22	10.58	11.27	9.3
Sunday ...	23	—	0.2	8.9
Monday ..	24	0.44	1.31	8.10
Tuesday...	25	2.19	3.2	9.7
Wednesday	26	3.41	4.14	10.8
Thursday..	27	4.41	5.5	11.9
Friday ...	28	5.26	5.46	12.9
Saturday .	29	6.5	6.24	13.6
Sunday .	30	6.43	7.2	13.9

E. CLEMENS, Harbour Master.

China Clay Exports for July, 1928

A RETURN showing the quantities and values of the exports of China Clay, including Cornish or China Stone, the manufacture of Great Britain and Northern Ireland from Great Britain and Northern Ireland as registered in the month of July, 1928 :—

COUNTRY OF DESTINATION.	QUANTITY. Tons.	VALUE. £
Finland	931	2,087
Latvia	821	1,327
Sweden	2,614	4,229
Germany	2,308	5,537
Netherlands	3,666	8,727
Belgium	3,839	9,367
France	2,266	5,376
Portugal	71	234
Spain	1,890	5,199
Italy	933	2,562
Greece	10	60
China	6	30
United States of America	20,467	44,540
Mexico	51	214
Peru	7	36
Brazil	10	39
Irish Free State	1	8
Cape of Good Hope	1	14
British India, via Bombay	1,026	4,086
Via Madras	5	25
Via Bengal, Assam, Bihar and Orissa	330	1,052
Australia	6	50
New Zealand	—	2
Canada	25	130
Total	41,284	91,922

July Deliveries

THERE was an improvement of 14,000 tons in the turnover by China Clay firms in July over the tonnage for June. The adverse balance against this year compared with last is now over 66,000 tons. Details of deliveries :

	CHINA CLAY.		CHINA STONE.		BALL CLAY.		TOTAL.	
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
PORT.	1928.	1927.	1928.	1927.	1928.	1927.	1928.	1927.
Falmouth ...	190	1,070	—	—	—	—	190	1,070
Fowey	59,006	53,966	3,361	5,785	2,072	1,504	64,439	61,255
Par	2,372	4,137	159	431	—	—	2,531	4,568
Penzance	455	1,793	—	—	—	—	455	1,793
Charlestown..	2,670	7,621	—	—	—	—	2,670	7,621
Plymouth....	1,654	552	—	—	—	—	1,654	552
By rail	3,832	3,742	—	—	—	—	3,832	3,742
July	70,179	72,881	3,520	6,216	2,072	1,504	75,771	80,601
Total 6 months	383,058	438,796	24,839	28,777	11,742	13,437	419,639	481,010
Total for 7 months ..	453,237	511,677	28,359	34,993	13,814	14,941	495,410	561,611

China Clay Imports for July, 1928

A RETURN showing the quantities and values of China Clay, including China Stone, imported into Great Britain and Northern Ireland as registered in the month of July, 1928, is as follows :—

COUNTRIES WHENCE CONSIGNED.	QUANTITIES. Tons.	VALUE. £
Germany and Total	15	92

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

Mortgages and Charges

[*NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.*]

BIRKS RAWLINS AND CO., LTD., Stoke-on-Trent, china manufacturers.—Registered July 19, debenture to Bank ; general charge.

BLAIRS (LONGTON) LTD., earthenware manufacturers.—Registered July 9, £4,000 debentures to P. Elliott, The Close, Hartshill, Stoke-on-Trent ; general charge. *Nil. March 19, 1928.

BLANCHARDS (BISHOP'S WALTHAM) LTD., brick manufacturers.—Registered July 16, £5,000 debentures ; general charge.

BODELVA CHINA CLAY CO., LTD., St. Austell.—Registered July 18, £400 debentures, part of £1,000 . general charge. *£1,500. April 11, 1927.

GEORGE STREET POTTERY, LTD., Tunstall.—Registered July 2, £2,500 1st debenture, to Branch Nominees, Ltd., 15, Bishopsgate, E.C. ; charged on land at Stoke-on-Trent, also general charge ; also registered July 19, mortgage to Bank ; charged on George Street Pottery, Tunstall, together with plant, machinery, etc.

HAMMILL BRICK CO., LTD., London, E.C.—Registered June 30, £10,000 debentures ; general charge.

MARTON BRICKWORKS CO., LTD., Marton (Yorks).—Registered July 14, £1,500 debenture, to West Riding Finance Corporation, Ltd., Huddersfield ; charged on company's leasehold property, also general charge.

U.S. Production of Fuller's Earth, 1927

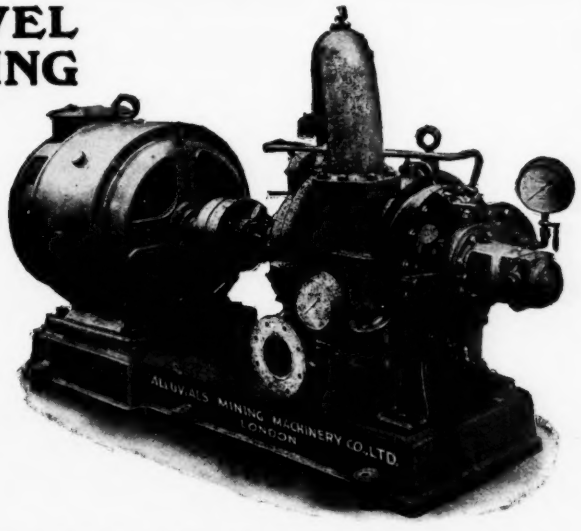
THE fuller's earth sold or used by producers in the United States in 1927 amounted to 264,478 short tons, valued at $3,767,038. This announcement is made by the United States Bureau of Mines, Department of Commerce, which has collected statistics in co-operation with the Geological Surveys of Florida, Georgia, Illinois, and Texas. This is an increase of 13 per cent. in quantity and 12 per cent. in value compared with 1926. Every important producing State except Illinois and Texas showed an increase. The output was reported by 16 operators in 7 States in 1927, namely, Arizona, Florida, Georgia, Illinois, Massachusetts, Nevada, and Texas. Georgia was the leading State in production in 1927, with Florida second and Nevada third. These three States produced 79 per cent. of the total output. The average value per ton of fuller's earth was $14·24 in 1927 compared with $14·33 in 1926.

Fuller's earth is a term used to include a variety of natural substances that possess the property of absorbing grease or clarifying, bleaching, or filtering oil. They are mostly clay-like substances, though recently-discovered material in the West (United States), which is of different character, is said to be superior to the eastern fuller's earth. The original use of fuller's earth was in the fulling of cloth, but little of it is now used for this purpose. It is used almost exclusively in the bleaching or filtering of vegetable and mineral oils. Until 1895, when fuller's earth was successfully produced commercially in Florida, the United States was entirely dependent on foreign supplies. In 1927 the imports of fuller's earth were 7,580 short tons, valued at $109,281, a decrease of 17 per cent. in quantity and 12 per cent. in value compared with 1926. The exports of fuller's earth are not separately shown in the official records of the foreign commerce of the United States, but 6 producers reported to the Bureau of Mines that in 1927 they exported 12,287 short tons of fuller's earth, which was an increase of 85 per cent. over 1926.

The China Clay Trade Review

The Official Organ of the China Clay Industry and the only Journal specially devoted to its interests.

PIONEERS IN GRAVEL AND SAND PUMPING



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WHERE TO BUY

A Classified Buyers' Guide for China Clay, Machinery, Sacks, Tools, and Allied Lines

AERIAL ROPEWAYS.
British Ropeway Engineering Co., 7, Mincing Lane, London.

AUCTIONEERS.
Hancock & Sons, Sydney Place, St. Austell.

BAGS AND LINERS (COTTON).
Feltham, W. H., & Son, Tower Bridge Road, London, S.E.1.

BANKS.
Barclays Bank, Limited.

CANVAS GOODS.
The N.F. Waterproofing Co., Ltd., Woodside Lane, N. Finchley, N.12.

CHINA CLAY AND CHINA STONE.
Best, Jas., & Sons, Longport, Stoke-on-Trent.
Bloomdale China Clay Co., Ltd., 80, Bishopsgate, E.C.
Burthy China Clay Co., Y.M.C.A. Buildings, St. Austell.
Carbis China Clay & Brick Co., Y.M.C.A. Buildings, St. Austell.
Catalpo, Ltd., London.
Dartmoor China Clay Co., Ltd., 11, Queen Victoria St., E.C.4.
Dyer, Samuel J., Market Hill, St. Austell.
English China Clays, Ltd., St. Austell.
Fox, Roy & Co., Plymouth.
Grose & Stocker, Stoke-on-Trent.
Lovering, J., & Co., St. Austell.
New Consolidated Mines of Cornwall, Ltd., St. Austell and London.
New Halwyn China Clay Co., Y.M.C.A. Buildings, St. Austell.
Newquay China Clay Co., Ltd., Newquay, Cornwall.
North Goonbarrow China Clay, Ltd., 3, Victoria Place, St. Austell.
Parkyn & Peters.
Pochin, H. D., & Co., Manchester.
Somerset Oxide and Ochre Co.
Tehidy Minerals, Ltd., 3, St. Petroc House, Bodmin, Cornwall.
Trethowal China Clay Co., Y.M.C.A. Buildings, St. Austell.
United China Clay Co., Ltd., 80, Bishopsgate, E.C.2.
Varcoes China Clays, Ltd., 107, Market Street, Manchester.
West Carclaze China Clay Co., St. Austell.
Wood, T.A.V., Ltd., Grant's Walk, St. Austell.

COALS.
Cornish Mines Supplies Co., Ltd., St. Austell.
Dunkerton Collieries, Dunkerton, near Bath.
H. Rees Jones & Co., Cardiff.
Stockwood, Rees & Co., Ltd.
Welsh Navigation Steam Coal Co., Ltd., Cardiff.

COLLIERIES.
Dunkerton Collieries, Ltd., Dunkerton, near Bath.
Rees Jones & Co., Ltd., Cardiff.

COLOURS AND CHEMICALS.
Brown, R. B., & Co., 45, Finsbury Square, E.C.
Podmore, W. & A. J., Caledonian Mills, Shelton, Stoke-on-Trent.

ELECTRICAL ENGINEERS.
Harry H. Gardam & Co., Ltd., Staines.

ENGINEERS.
Holman Bros., Camborne.
Paulis (Engineers), Ltd., Fowey.
Sidney Smith & Blyth, Ltd., Garratt Lane, Wandsworth, S.W.18.

FILTERPRESS.
Premier Filterpress Co., Finsbury Pavement House, E.C.

GAS ENGINES.
Crossley Bros., Ltd., Manchester.

IRONMONGERS.
Cornish Mines Supplies Co., Ltd., St. Austell.
Stocker, F. E., Ltd., St. Austell.
Hawke & Son, St. Austell.

LAND & MINE SURVEYORS.
Trythall & Champion, Camborne.

LUBRICANTS.
Cornish Mines Supply Co., Ltd., St. Austell
Reliance Lubricating Oil Co., Ltd., 19–20, Water Lane, E.C.
Willcox, W. H., & Co., Ltd., 32–38, Southwark Street, London, S.E.1.

MINING ENGINEERS.
Rich, Wm., & Sons, Redruth.

MINING MACHINERY.
Alluvials Mining Machinery Co., 2, Broad Street Place, E.C.
Cornish Mines Supplies Co., Ltd., St. Austell.
Hadfields, Ltd., East Hecla Works, Tinsley, Sheffield.
Rich, Wm., & Sons, Redruth, Cornwall.

MINING SUPPLIES.
Cornish Mines Supply Co., Ltd., St. Austell.
Hadfields, Ltd., East Hecla Works, Tinsley, Sheffield.
Holman Bros., Camborne.
Rich, Wm., & Sons, Redruth, Cornwall.

MOTOR TRANSPORT.
Mid-Cornwall Transport Co., Ltd. (1922), Bodmin Road, St. Austell.

PIPES.
British Mannesmann Tube Co., Ltd., Salisbury House, London Wall, E.C.2.
Ryland, A., Cradley Heath, Staffs.

PUMPS.
Alluvials Mining Machinery Co., 2, Broad Street Place, E.C.
Cornish Mines Supplies Co., Ltd., St. Austell.
Willcox, W. H., & Co., Ltd., 32–38, Southwark Street, London, S.E.1.

QUARRYING AND MINING REQUISITES.
Cornish Mines Supplies Co., Ltd., St. Austell.
Hadfields, Ltd., East Hecla Works, Tinsley, Sheffield.
Rich, Wm., & Sons, Redruth, Cornwall.
Warden, F. H., Ltd., Birmingham.

RAILS (Bridge, Flange, Double or Bullhead).
Bute Works Supply Co., Ltd., 53, Cymric Buildings, Cardiff.

RAILWAY WAGONS.
Bute Works Supply Co., Ltd., 53, Cymric Buildings, Cardiff.
Roberts, Charles, & Co., Ltd., Horbury Junction, nr. Wakefield.

ROPES.
Cornish Mines Supplies Co., Ltd., St. Austell.

SHIPBROKERS.
Blake, G. A., 11, High Cross Street, St. Austell.
Ludlow & Sons, Penzance.
Simpson, Spence & Young, London.
Toyne, Carter & Co., Fowey.

SACKS & BAGS.
Andrew Weir & Co., 21, Parliament Street, Liverpool.
Boag, Thos., & Co., Ltd., Greenock.
Cornish Mines Supplies Co., Ltd., St. Austell.
Dovener, J. H., & Co., Union Street, Liverpool.
North Mills Co., Ltd., Little Peter Street, Manchester.
The N.F. Waterproofing Co., Ltd., Woodside Lane, N. Finchley, N.12.

TIMBER IMPORTERS.
Cornish Mines Supplies Co., Ltd., St. Austell.
Fox, Eliott & Co., Plymouth.
T. Warne, St. Austell.

WATERPROOFING.
The N.F. Waterproofing Co., Ltd., Woodside Lane, N. Finchley, N.12.

WIRE ROPES.
Hood Haggie & Son, Ltd., Newcastle-on-Tyne.
Stephens, John, & Son, Ltd., Falmouth, England.

The China Clay Trade Review

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The China Clay Business

THERE are very few industries producing raw materials and proprietary manufactured articles which have not fixed standard prices for their goods, the infringement of which prices brings upon offenders punishment in the way of penalties, or a withdrawal of the supply of the article sold.

Recently, in the China Clay industry, the question has been raised in a somewhat acute form through certain merchants selling to consumers at below the consumer's price by adopting the expedient of sharing with other customers the percentage margin allowed by the producers.

The Function of the Merchants

As showing the seriousness with which certain large producers viewed this infringement of what has been a concession to merchants, they recently proposed that in future the whole of the selling of China Clay should be done direct to consumers, the effect of which would be to eliminate the merchant altogether. The infringement referred to is regarded by the producers as all the more aggravating since the margin allowed has been as large as it is because merchants insisted, when the arrangement was made, that a smaller percentage would not be remunerative. Yet some of them, it has since been found, have been able to afford to share it with their customers, thus securing an unfair advantage over the producer who sells direct to the consumer.

The Selling Machinery

As regards the machinery by which the China Clay industry has supplied the markets of the world with its commodity, the discussion that has ensued over the proposal to eliminate the merchant throws an interesting sidelight. Undoubtedly, in the early days and since, the industry has owed a great deal to the enterprise and energy of the merchants, who have introduced China Clay into quarters and opened up markets in countries which it would have been difficult for individual producers to enter on their own account. It is only natural, therefore, that merchants should not have been slow to show their objection to any proposal on the part of the industry to dispense with their services by supplying the market direct.

Except for the very large firms, many producers have not the sales organisations necessary to do a direct-to-consumer business. Consequently they rely almost wholly upon the merchant to distribute their product to the consumer. Following the ventilation of the subject and the concern with which the proposal to eliminate the merchant was viewed in many quarters, we understand that it is not now being pressed.

There is another aspect of the question that has not been considered, but which might have an important bearing upon sales, and that is that many consumers of China Clay as a raw material in their products prefer to buy from merchants rather than from producers, in their desire to avoid it becoming too generally known that they are using China Clay in certain manufactures which are more or less concerned with their secret processes.

Uses Widening

The uses of China Clay have greatly widened since its value was first realised in the papermaking, pottery and bleaching trades, so that to-day there is scarcely an article of household or personal use for cleansing purposes that does not contain China Clay in some form or other as an ingredient. Certain purposes for which it is used are known only to the makers, who maintain the secrecy of its use in the articles they manufacture. The uses to which China Clay is put are continually being added to, and to-day the bulk of it is taken by papermakers, potters, bleachers and chemical manufacturers.

Manual Labour Changes

On the employment side, the China Clay industry in Cornwall is one of the biggest employers of labour, but the demand for manual labour has decreased materially in recent years, especially in the last 15 years, through the introduction of mechanical methods of production, which have displaced the demand for so large a number of unskilled workmen such as was required formerly. This reduction of manual labour has been seen mainly in the pit work, where mechanical contrivances for breaking, washing and lifting the clay and refuse (in the shape of sand and over-burden) have been introduced. Some years ago a census of manual workers showed that approximately 5,000 men were employed in the China Clay industry, but nowadays the total number is very much smaller. As the tendency continues for all possible work in connection with China Clay production to be done by machinery and mechanical means, the demand for manual labour will become less rather than more. Consequently the young men of the clay districts will have to look for some other outlet for the unskilled labour they have to offer, or, which would be ultimately much more to their advantage, to acquire the knowledge which would place them in the skilled labour market.

Foreign Competition Aided by the War

Had it not been for circumstances arising out of the war, when, because of the difficulty foreigners had in getting their supplies, attention was directed to the deposits of kaolin in other countries, the China Clay industry to-day would be very much more flourishing than it is and would be giving much more employment. Having started the exploitation of their deposits, producers from foreign mines have been coming increasingly into competition with producers of our own clays. It is only because the world consumption of China Clay has greatly increased that the present sale of home-produced China Clays approximates to the pre-war figure.

Rate Aid Hopes

The industry is now expectantly looking forward to the benefits it will receive under the Government's rating reform scheme (which, it is expected, will come into operation towards the end of next year) as a means of assisting it in placing its product on the market under more favourable terms. As two-thirds of the local trade is export, it will be seen that the maintenance and development of overseas markets is a matter of great importance.

British Association Meeting

Paper on China Clay

On Wednesday, September 12, "The Geology and Economics of the China Clay Industry of the West of England" were discussed at the Glasgow meeting of the British Association for the Advancement of Science, in a paper by Mr. E. H. Davison, head of the Department of Geology and Mineralogy at the School of Mines, Camborne, Cornwall, before Section C (Geology). China Clay, he said, had been worked in Cornwall and Devon since the beginning of the last century, and 800,000 tons were produced in 1927.

China Clay rock occurred in all the granite outcrops of the West of England, but the Hensbarrow district, near St. Austell, and the southern part of Dartmoor, were the areas producing the best quality clay. It occurred as a soft, altered granite, which could be dug out with a spade, the result of the action of gases and solutions which were given off after the granite had consolidated, and which came up along fissures in the solid rock, changing the felspar in the rock on either side to China Clay.

Evidence for Method of Formation of Clay

As evidence of his statement, Mr. Davison said that: (1) The China Clay rock was more completely kaolinised near the fissure lodes and "stent" lodes, and the completeness of kaolinisation increased with depth; (2) the occurrence of the China Clay was associated with the occurrence of such minerals as tourmaline, gilbertite and sericitic mica; (3) the physical characters of the West of England China Clay were markedly differed from those of clay of obvious meteoric origin; (4) clay deposits occurred with a covering of unaltered granite; (5) though clay deposits had been worked to a depth of 350 ft., no instance was known of a deposit dying out in depth.

Dealing with the method of working, he said that the clay rock was worked in open pits by sluicing with water under pressure, delivered through monitors, the clay and hard constituents of the rock (the sand) being washed to the bottom of the pit, where the sand was settled. The sand was then trained to the top of tall waste heaps. The clay-bearing water was pumped to the top of the clay pit, and passed through narrow channels (the "Micas"), where the fine mica was settled, together with any coarse clay and fine quartz. The water and clay passed on to the settling tanks, where the clay settled, and almost clean water came off. From the settling tanks the clay was passed to larger tanks, some 60 ft. by 40 ft. by 8 ft., adjoining the drying kiln, which was usually situated close to the mineral railway. In these tanks the clay settled until the water content was reduced to 50 per cent. or less. It was then transferred to a shallow pan running along the whole length of the five or six settling tanks, and heated from below by means of hot air flues. Whey dry, it was transferred to a floor below the drying pan, and subsequently transferred to the railway trucks.

Quality and Yield

The clay was of two qualities. The first was the best clay or bleaching clay, used for paper making, filling cloth, etc., and had to have a fine grain and pure white colour. This sold at 45s. to 70s. per ton. The second quality was the potting clay, used for porcelain making, and it had to frit at a high temperature to yield a white brick. It sold at 30s. to 45s. per ton. The product of the first settlement, called "Mica," was also sold, at 15s. to 22s. per ton. This was used for making rough paper, boards, etc., but it was considered a by-product, and was not estimated in determining the production.

China Clay rock yielded from 10 to 32 per cent. of clay. The cost of production varied; the selling price depended on quality. Thus, the prosperity of a pit depended largely on the proportion of best clay it produced. Moreover, the better clays were easier to market than were the lower qualities. The great danger in working clay was shortage of water, as this would stop or seriously hinder production. Water which had been used to transport the clay had to be returned to the clay pit afterwards.

Among the recent innovations in clay working was the installation of gravel pumps, which lifted both the clay and the sand to the surface, and thus saved the cost of training. Filter presses had also been installed, to quicken the rate at which the clay could be dried.

The clay industry was controlled by an association which included the great majority of clay pits. It controlled the prices at which the various qualities were sold, as well as the amount sold by each pit during the year. At the same time, it guaranteed each pit its fair proportion of sales, the proportion being based on an allotment which was determined by the producing power of the plant at each pit. Though China Clay occurred in many other parts of the world, said Mr. Davison, no foreign clay could at present compete with the Cornish and Devon clay, which was exported to all civilised countries.

The Weathering of Clay

A Japanese Research

A PAPER on "Changes of Certain Clays into Acidic Ones through Weathering" by Tsuruji Okazawa is contained in the July number of the *Journal of the Institute of Physical and Chemical Research of Tokyo*. There are some sorts of natural clays, states the author, which show acid behaviour, such being, for example, fuller's earth and Florida earth. Such clays are called acidic clays. Reasons for presenting acidity often are discussed, but there is given no explanation about the manner of the change of certain clays into acidic ones. The author examined a number of mountains conspicuously localised and producing acidic clays, in Japan, and found out that for every one of such mountains, acidity shown is limited to the upper surface, and it decreases towards the interior, becoming neutral and alkaline at last, although the whole seems, of course, to consist throughout of the same clay on outward appearance. As a matter of fact, acidic clays are of igneous formation in nature, and do not form any strata.

Variation of Acidity with Depth

The strength of acidity differs much for individual mountains, but generally speaking, it is stronger in those which lie nearer the sea-coast. It is remarkable that the depth to which the acidity subsists is nearly proportional to the strength shown on the upper surface. Thus, in the mountains showing the strongest acidity in the upper surface, feeble acidity is traceable to a vertical depth of twelve metres, while in those which are of weak acidity it was ascertained that at the depth of only about two metres from the surface the clay is already neutral if not alkaline. There are also some mountains consisting of tuff, not of clays, which have become clayish through weathering, showing acidity at their upper surfaces which decreases towards the interiors.

Now in Japan, mountains of acidic clay are for the most part localised in the provinces facing the Sea of Japan. In that locality, wind is generally strong during autumn and winter, and snow rich in sea-salt falls abundantly even to a depth of 4-5 metres. The salinity is so intense that the acerose trees cannot grow fully near the coast.

Action of Salt

After several years' study, the author has been led to believe that the acidity presented by clays is due to the weakness of the combination between silicic acid and alumina, and the consequent easy dissolution of this alumina into a solution of neutral salt, instead of being such a mechanical phenomenon as adsorption. This is an evident explanation why the surface only of an acidic clay mountain presents acidity, which decreases till finally either vanishing or presenting alkalinity. That is to say, as the author conjectures, acidic clay is formed from the original substance, either alkaline or neutral, which being weathered by saltish wind, rain and snow, is at length not only decomposed but results in the weakening of the combination of silicic acid with alumina.

If the above conjecture be experimentally verified, the reason of the acidual change of acidic clay and a few other silicates will be cleared up, and at the same time, the explanation for abundance of acidic clay in the sea-coast visited by such wind and precipitations as those mentioned above, and its rarity in the mountains near the Pacific Coast and the inland. The present paper is only a preliminary one, and the results of further investigations will be reported later on.

Refractory Clay Industry in Saskatchewan

A Review of the Situation

CLAYS suitable for the manufacture of common brick and tile are of general occurrence in nearly all parts of Canada, but known deposits of the higher grades of clays—clays suitable for the manufacture of pottery, vitrified wares, and articles having high heat-resistant qualities—are much less common. Saskatchewan has probably a greater variety of clays, in larger quantities and inclusive of the higher grades than any other Canadian province, and, as the country becomes more thickly populated, there will, without doubt, grow up in southern Saskatchewan—and in neighbouring parts of the adjoining province of Alberta, where high-grade fuel in the shape of bituminous coal and natural gas is cheap and plentiful—a very important ceramic industry.

Government Action

In order to assure the best and most competent guidance for the future development of its clay industry the Saskatchewan Provincial Government, in conjunction with the University of Saskatchewan, has entered on a careful survey of the clays and of the ceramic possibilities of the province, and has established at the Provincial University a course in ceramic engineering under a highly trained specialist—the first of its kind to be undertaken by a Canadian University. In connection with this, a complete equipment of clay-working machinery and kilns has been installed for the testing of clays and allied materials.

Among the known and tested deposits of Saskatchewan clay a number have been found suitable for use wholly or in part in the manufacture of: pottery or light ware (white-ware, granite ware, electrical porcelain, sanitary ware, wall and floor tile, yellow ware, and stoneware); heavy ware (sewer-pipe, hollow-ware, paving brick, building brick, terra-cotta, and roofing-tile); and refractories (locomotive-tile, stove linings, fire-proofing, fire-bricks and shapes).

Method of Working

All the clays of Saskatchewan are transported clays; residual clays are not known to occur in the province. Their winning is a simple matter; nearly all can be worked by open-pit methods and even the high-grade refractory clays are so well exposed that underground mining will not be necessary for a long time to come. The chief localities in which high-grade clays have been dug are at Clay Bank, Willows, and East End, in southern Saskatchewan. At Clay Bank on the Avonlea-Gravelbourg branch of the Canadian National Railways, the Dominion Firebrick and Clay Products Co. manufacture a number of special lines of refractories, including flue and furnace linings, linings for straw and coal-burning engines, locomotive arch tile, etc., from clays dug in the neighbourhood.

White-burning ball-clays and clays of the semi-refractory type dug at Willows, 74 miles south of Moose Jaw on the Weyburn-Lethbridge branch of the Canadian Pacific Railway, are shipped to Medicine Hat, Alberta, where they are used in the manufacture of whiteware and stoneware by Medalta Potteries, Ltd., and Alberta Clay Products, Ltd., as well as for sewer-pipe, refractories, etc. Ball-clay from Willows has also been used in Ontario potteries.

Silica Deposits in Western Canada

THE Mines Branch of the Dominion Department of Mines has just issued Part II of Mr. L. E. Cole's Report (No. 686) on *Silica in Canada—Its Occurrence, Exploitation and Uses.* This section of the report covers the territory from Fort William, Ontario, to the Pacific Coast in British Columbia, and the field work in connection with the report was carried on during 1925 and 1926. An appendix to the report includes particulars of recent developments in the silica industry in eastern Canada which have taken place since the issue of Part I. Copies of the report may be obtained by firms interested on application either to the Mines Branch, Department of Mines, Ottawa, or to the office of the High Commissioner for Canada, The Canadian Building, Trafalgar Square, London, S.W.1.

Sir Charles Cottier's Sudden Death

Impending Developments to be Completed

ON Wednesday, August 22, Sir Charles Cottier, who had taken the lead in the negotiations in connection with the pending formation into a limited company of John Lovering and Co.'s China Clay business, died suddenly at his residence near Henley. It is understood this will not affect the carrying through of the operations above referred to, as the financial arrangements were practically completed at the time of Sir Charles' death.

Sir Charles Cottier, who was born in 1869, was a son of Mr. Francis Cottier, of County Cork and Plymouth. He served his articles at Plymouth, and became partner in the firm of Lane and Cottier, solicitors. He established a branch of this business in London, and became interested in company finance. He was chairman of the Criterion Restaurant, the Aerated Bread Company, Booth's Distillery, and Stephen Smith and Co., which specialises in Hall's Wine. He was a strong advocate of tariff reform, and was honorary treasurer of the Empire Industries Association. A knighthood was conferred on him in 1924. In 1889 he married Lydia Imane Avent, and leaves, besides his widow, two sons and two daughters.

[Photo Lafayette

THE LATE SIR CHARLES COTTIER.

The news of Sir Charles' death came as a great shock to his friends in Cornwall, particularly in Newquay and St. Austell, where he was an occasional visitor, mainly in connection with Hensbarrow China Clays, Ltd., in which he had a controlling interest. Within the last few weeks Sir Charles had been in the district, and stayed with his son, Mr. C. M. Cottier, at Carnsmerry Crescent, St. Austell, whence he was called suddenly back to London in connection with the work of Sir John Jackson, Ltd., which has the Admiralty contract for the Singapore naval base, and of which company he was the managing director.

It was one of Sir Charles Cottier's ambitions to consolidate the China Clay industry into one concern, and it was expected that his bigger interests in the industry were a move in this direction.

A Catalogue of Sands and Clays

A NEAT folder, giving a catalogue of sands, clays, and refractory materials for all industrial purposes, has been issued by Algernon Lewin Curtis, of Westmoor Laboratory, Chatteris, England. The list is alphabetical, the name of each material supplied being followed by a short note on its uses. The range is very wide, and includes not only sands and clays, etc., but numerous other substances, such as graphite, lime, mica, ochres, umbers, whiting, etc., etc.

China Clay Notes and News

Clays in 1927

In the seventh annual report of the Secretary for Mines appear the following particulars of minerals used in china, pottery, and glass manufacture. This group comprises China Clay, potters' clay (including Ball Clay), China Stone, limestone, and sand for use in glass-making, and chert used in the china and pottery trades. Particulars are shown in the following table :

Statement Showing the Quantity and Net Selling Value of Minerals Used Mainly in China, Pottery and Glass Manufacture.

Kind of Material.	Raised or Quarried Tons.	Average Net Selling Value Per Ton. £ s. d.
China Clay	869,232	1 8 6
Potter's Clay (including Ball Clay)	190,942	0 18 7
China Stone	63,612	1 7 10
Limestone for Use in Glassmaking	32,872	0 5 11
Sand for Use in Glassmaking	83,278	0 3 4
Chert, for Use in China and Pottery Trade	1,351	2 9 2

The production of China Clay in Great Britain for 1927 amounted to 869,000 tons, as compared with 850,000 tons in 1925 and 813,000 tons in 1913. The total number of persons employed in the industry in 1927 was 4,544, as compared with 4,715 in 1925. The export trade was well maintained, the total exports amounting to 656,000 tons (including a small amount of China Stone), as compared with 653,000 tons in 1925. Of the total, the United States took about 40 per cent. The other principal importers were Scandinavia, Belgium, Netherlands, India, Germany, France, Italy and Spain, in the order named.

The output of potter's clay (including Ball Clay) in 1927 was 191,000 tons, as compared with 207,000 tons in 1925, a reduction of 8 per cent. The output of China Stone was 63,600 tons in 1927, as compared with 57,400 tons in 1925, an increase of 11 per cent. The chert for use in the china and pottery trades amounted to 1,351 tons in 1927, as compared with 1,387 tons in 1925. The sand for use in glassmaking amounted to 83,700 tons in 1927, as compared with 78,400 tons in 1925, an increase of 7 per cent. Limestone for use in glassmaking amounted to 33,000 tons in 1927, as compared with 30,000 tons in 1925, an increase of 10 per cent.

Pottery Trade in August

Returns from the employment exchange of the city of Stoke-on-Trent and the adjoining borough of Newcastle-under-Lyme gave the numbers of unemployed persons connected with the pottery industry of North Staffs for the weeks ended July 16, 23 and 30, and August 13 and 20 as 8,526 ; 9,203 ; 9,375 ; 13,858 ; and 11,285 respectively. These figures furnish unmistakable evidence of the important fact that this industry taken as a whole remains in a state of depression, and the great August holiday period stands out even worse than for any of the bad years immediately preceding, excepting, of course, the period of the acute coal trouble in 1926.

Most works were closed during the summer of the present year for two or more weeks instead of the single week which was the normal extent of the summer holiday before the prolonged period of depression set in.

From an examination of the Board of Trade returns for the last three years, it appears that exports of china and translucent pottery—other than electrical ware—for July and for the first seven months of the year were actually, as regards values for both the single month and the seven months period, highest this year.

It may be noted that the total exports of pottery (including tiles, sanitary ware, and other classes of clay products) were substantially greater both in quantity and value for July and for the seven months of 1928 than in the corresponding periods of either of the two preceding years. This, however, is not strictly true of all the several classes—such as general earthenware, cloam ware, etc., which are ordinarily grouped together as " pottery."

New Patents

273,258. Clay Products, Ceramic Composition and Associated Processes.

The Vitrefrax Co., Huntingdon Park, Los Angeles, California, U.S.A. (assignees of T. S. Curtis, 542, South Stafford Avenue, Huntingdon Park, Los Angeles).—This invention involves, in one phase, a novel clay product ; and, in a second phase, a new clay product strengthener which, when combined with known clays, produces a clay product of advantageous characteristics not heretofore obtained, together with certain processes incidental to the procurement of the foregoing. The invention consists of special novel treatment or treatments of the mineral substance employed for purposes of clay strengthening ; the utilisation of the aluminium silicate the fibrous structure of which is derived mainly from kyanite crystals, which possesses the unique characteristic of growing in length whilst not materially changing in thickness under the action of predetermined heat control ; and the handling of the said kyanite crystals according to special processes and controlled conditions to obtain the composition therefrom useful for the purposes of the invention (20 claims).

281,254. Method of Manufacturing Porous Refractory Bricks and the Like.

I. Setterberg, Kungsgatan, 33, Stockholm, Sweden. The invention consists chiefly in this, that finely-powdered refractory materials such as refractory clay, chamotte, kaolin, quartz, quartzite, flint, magnesite, dolomite, chromite, or the like are mixed with water to the consistency of a plastic dough, and at the same time a susbtance capable of evolving gas by reaction with water such as, for instance, pulverulent aluminium, calcium, zinc, calcium carbide, etc., is added, which is intimately and uniformly distributed in such dough, and causes an effervescence in the same on account of its reaction with water. After completion or termination of this effervescence the mixture is formed into blocks, which are dried and finally burned at a high temperature until the material is baked together by sintering (one claim).

Clay Abstracts

The July number of *Building Science Abstracts* (H.M. Stationery Office, 9d.), includes in its contents, as usual, a number of abstracts dealing with clays and allied substances. Among these are abstracts on " Sand Settling and Devices for Settling and Classifying Sand," by E. Shaw (from *Rock Prod.*, 1928, 39-43) ; " Relation of Grading and Voids in Sand " (from *Rock Prod.*, 1928, 56-7) ; " The Petrographic study of sand in the determination of its resistance to atmospheric influences," by Maddalena (from *Rivista tecnica delle Ferrovie italiane*, 1928, January 15) ; " The constitution of clay mud,' by H. Chatley (from *Proc. Inst. Civil Eng.*, 1927, 3-15) ; and " The decomposition of clays," by L. Wasilewski (*Chem. Abs.*, 1928, 2,245).

The St. Austell Post Office

No institution in a town marks its commercial progress more than the operations of its post office, and these operations are more demonstrative of such progress in the case of St. Austell than of many other towns. With the staff, organisation, and fine commodious and up-to-date premises of the St. Austell Post Office to-day, the primitive methods and leisurely ways of the old postal officials and their crude equipment have been left far behind. In the opening of the new post office in the spring of 1922, local postal organisation reached the peak of efficient equipment and expeditious working. The growth of post office business in St. Austell has been coincident with the development of the China Clay industry, and the centralisation within the last twenty years of its sales organisations. Twenty-five years ago the predecessors of English China Clays, Ltd. and John Lovering and Co. were the only leading firms who had selling organisations and office staffs in St. Austell, and as regards these two a large part of their business on the selling side was conducted through offices up country. Now there are few clay companies that have not their chief sales organisations in the town, the result of which has been enormously increased demands upon the resources of the Post Office.

Shipping and Export News of the Month

We give herewith latest particulars relating to arrivals and sailings of ships engaged in the China Clay trade, at the principal British clay ports. Registered exports of China Clay, with countries of destination, and other shipping and export matters are dealt with.

Fowey Shipping—August, 1928

Arrived.	Name.	Sailed.	Destination.
August 1, S.S.	*Victoria*	August	3, Garston
August 1, S.S.	*Pylades*	August	2, Methil
August 1, S.S.	*Torquoise*	August	3, Glasgow
August 1, S.S.	*Farfield*	August	3, Grimsby
August 2, S.S.	*Primrose*	August	7, Weston Pt.
August 2, S.V.	*J. H. Barrow*	August	9, Granton
August 3, S.S.	*Knowlgrove*	August	8, Newcastle
August 4, S.S.	*Teespool*	August	16, Philadelphia
August 5, S.S.	*Brynawel*	August	10, Rouen
August 6, S.S.	*Gouwestroom*	August	11, Amsterdam
August 9, S.S.	*Alfa*	August	11, Halden
August 10, M.V.	*Dankward*	August	13, Stettin
August 10, S.V.	*Najaden*	August	14, Stettin
August 10, S.S.	*Pansy*	August	11, Leith
August 10, S.S.	*Mersey*	August	15, Ridham
August 10, S.S.	*Strudsholm*	August	14, Fort William
August 10, S.S.	*Suffolk Coast*	August	15, Liverpool
August 10, S.S.	*Scheldejol*	August	14, Gravelines
August 11, S.S.	*Blush Rose*	August	15, Grangemouth
August 11, S.S.	*Sturdee Rose*	August	16, Rouen
August 11, S.S.	*Hayle*	August	16, Manchester
August 11, S.S.	*Joffre Rose*	August	15, Preston
August 11, S.S.	*Calcaria*	August	16, Antwerp
August 13, S.V.	*Francis and Jane*	*	—
August 14, S.V.	*Mount Blairy*	August	18, Runcorn
August 15, S.S.	*Oakford*	August	18, Antwerp
August 15, S.S.	*Farfield*	August	18, Runcorn
August 16, S.V.	*Greenhithe*	August	20, London
August 17, S.S.	*Cisneros*	August	18, Genoa
August 17, S.S.	*Dorrien Rose*	August	22, Ghent
August 17, S.S.	*Brynawel*	August	22, Antwerp
August 17, M.S.	*Johannes*	August	20, Gothenburg
August 18, S.S.	*Teesbridge*	August	23, Portland, Me.
August 18, S.S.	*Primrose*	August	24, Rouen
August 18, S.S.	*Haig Rose*	August	22, Brussels
August 18, S.S.	*Fermain*	August	22, Pasages
August 19, S.S.	*Alekto*	August	23, Sarpsborg
August 20, S.S.	*Enigheden*	August	24, Norrkoping
August 21, S.S.	*Jarrix*	August	25, Antwerp
August 21, S.S.	*Lieutenant le Mounier*	August	25, Antwerp
August 21, S.S.	*Horsham*	August	25, Antwerp
August 21, S.V.	*Hilda*	August	25, Falmouth
August 22, S.S.	*Gouwestroom*	August	25, Amsterdam
August 22, S.S.	*Guelder Rose*	August	29, Weston Pt.
August 23, S.S.	*Holland Maru*	August	28, Boston and New York
August 23, S.S.	*Pylades*	August	27, Aberdeen
August 23, S.S.	*Cornish Trader*	August	27, Bremen
August 24, S.S.	*Phaeacian*	August	28, Rouen
August 24, S.S.	*Wild Rose*	August	29, Weston Pt.
August 24, S.S.	*Marta*	August	28, Harburg
August 24, S.S.	*Mersey*	August	25, Plymouth
August 25, S.S.	*Scheldejol*	August	28, Terneuzen
August 25, S.V.	*Thursonian*	September	4, Berwick
August 25, S.S.	*Ole Aarvold*	August	28, Milwaukee
August 25, S.V.	*Lady Agnes*	August	31, Goole
August 25, S.S.	*Pansy*	August	29, Bo'ness
August 26, S.S.	*Kentish Coast*	August	27, Liverpool
August 29, S.S.	*Hayle*	August	30, Preston
August 29, M.V.	*Valk*	August	31, Stettin
August 31, S.S.	*Pinto*	September	1, Genoa
August 31, S.S.	*Glenbrook*	September	1, Gravesend
August 31, S.S.	*Kristine I.*	September	3, Sheboygen
August 31, S.V.	*Hero*	*	Runcorn
August 31, S.S.	*Thurston*	*	Norfolk, Va.

Par Harbour Shipping—August, 1928

Arrivals

Date.	Vessel.	From
August 1, S.S.	*Solway Firth*	Newport, I.O.W.
August 1, S.V.	*C. and F. Nurse*	Falmouth
August 2, M.V.	*Isabel*	Plymouth
August 3, S.S.	*Mango*	Barry
August 4, S.S.	*Magrix*	Plymouth
August 5, S.S.	*Beauly Firth*	Blyth
August 7, S.V.	*Pet*	Garston
August 10, M.V.	*Amazon*	Penryn
August 10, S.S.	*Enterpriser*	Truro
August 10, S.S.	*Crouch Belle*	Penzance
August 11, S.V.	*Trevellas*	Fowey
August 15, S.S.	*Glenaen*	Bridport
August 15, M.V.	*Isabel*	Plymouth
August 16, S.V.	*Emma and Ester*	Falmouth
August 17, M.V.	*Lydia Cardell*	Rouen
August 18, M.V.	*Isabel*	Plymouth
August 21, S.S.	*Treleigh*	Portreath
August 23, S.S.	*Coaster*	Cardiff
August 25, S.V.	*Kate*	Falmouth
August 28, M.V.	*Ability*	London
August 28, S.S.	*Tanny*	Newport
August 29, S.S.	*Brockley Combe*	Port Talbot

Sailings

Date.	Vessel.	Destination.
August 1, S.V.	*Clymping*	London
August 1, M.V.	*Isabel*	Plymouth
August 2, S.V.	*Mary Barrow*	Rochester
August 3, S.V.	*Emily Warbrick*	Runcorn
August 3, S.V.	*My Lady*	London
August 3, S.S.	*Solway Firth*	Northfleet
August 4, S.S.	*Beaconray*	Antwerp
August 7, S.S.	*Mango*	Runcorn
August 8, M.V.	*Camborne*	Glasgow
August 8, S.V.	*C. and F. Nurse*	London
August 8, M.V.	*Isabel*	Plymouth
August 9, S.S.	*Magrix*	Gravesend
August 9, S.S.	*Beauly Firth*	Jersey
August 14, M.V.	*Amazon*	London
August 14, S.S.	*Enterpriser*	Queenboro
August 15, S.S.	*Crouck Belle*	Rochester
August 16, S.V.	*Trevellas*	Rochester
August 16, M.V.	*Isabel*	London
August 17, S.V.	*Pet*	Weston Point
August 18, S.V.	*Englishman*	Runcorn
August 18, S.S.	*Glenaen*	Terneuzen
August 18, M.V.	*Lydia Cardell*	Sunderland
August 21, M.V.	*Emma and Ester*	Runcorn
August 21, M.V.	*Isabel*	Plymouth
August 21, S.S.	*Treleigh*	Preston
August 24, S.S.	*Coaster*	Charlestown
August 30, S.S.	*Tanny*	Bristol
August 31, S.V.	*Kate*	Poole
August 31, M.V.	*Ability*	Charlestown

* Signifies " On Port."

Charlestown Shipping—August, 1928

Arrived.	Vessel.	From	Sailed.	Destination
July 16, S.V.	*Julia*	St. Davids	August 18,	Runcorn (Ground Felspar)
July 28, S.V.	*Elsa*	Brest	August 1,	Nantes
August 1, S.S.	*Treleigh*	Cardiff	August 4,	Preston
August 2, S.V.	*Snowflake*	Mevagissey	August 3,	Runcorn
August 2, S.V.	*Helena Anna*	Cardiff	August 30,	Antwerp
August 5, S.V.	*Rylands*	Falmouth	August 8,	London
August 5, S.S.	*System*	Goole	August 13,	Gravesend
August 9, S.V.	*Lady Daphne*	Plymouth	August 12,	Rochester
August 9, S.S.	*Greta*	Penzance	August 12,	Norrkoping
August 15, S.S.	*Barchan*	Hayle	August 16,	Tayport
August 23, S.V.	*Romanie*	Falmouth	August 26,	Nantes
August 23, S.V.	*Rothersand*	Gweek	August 28,	Runcorn
August 24, S.S.	*Coaster*	Par	August 27,	London
August 25, S.V.	*Lady Roseberry*	Poole	August 29,	Rochester

Par Harbour Tide Table, October, 1928

(Greenwich Mean Time Throughout.)

Day of Week.	Day of Month.	Morning.	Afternoon.	Height.
Monday ..	1	6.21	6.40	14.2
Tuesday....	2	6.59	7.17	14.0
Wednesday	3	7.36	7.55	13.6
Thursday...	4	8.15	8.36	12.8
Friday	5	8.58	9.23	11.7
Saturday ..	6	9.52	10.27	10.6
Sunday	7	11.9	11.56	9.9
Monday ...	8	—	0.46	9.9
Tuesday....	9	1.34	2.17	10.5
Wednesday	10	2.53	3.23	11.5
Thursday...	11	3.48	4.11	12.2
Friday	12	4.32	4.51	12.8
Saturday ..	13	5.9	5.26	13.0
Sunday ...	14	5.43	5.59	13.1
Monday ...	15	6.14	6.29	13.1
Tuesday....	16	6.43	6.56	12.9
Wednesday	17	7.9	7.23	12.4

Day of Week.	Day of Month.	Morning.	Afternoon.	Height.
Thursday...	18	7.38	7.53	11.8
Friday.....	19	8.8	8.24	10.11
Saturday ..	20	8.41	9.2	10.1
Sunday ...	21	9.25	9.52	9.4
Monday ...	22	10.26	11.7	8.10
Tuesday....	23	11.53	—	8.11
Wednesday	24	0.40	1.25	9.8
Thursday...	25	2.2	2.35	10.9
Friday.....	26	3.3	3.27	11.11
Saturday ..	27	3.49	4.10	13.0
Sunday ...	28	4.31	4.52	13.9
Monday ...	29	5.12	5.33	14.2
Tuesday....	30	5.54	6.16	14.3
Wednesday	31	6.37	6.57	14.0

E. CLEMENS, Harbour Master.

August Deliveries Up

THE turnover of China Clay firms has taken a distinct turn for the better, in August recording a monthly increase of 5,000 tons over July, which month showed an increase of 14,000 tons over June. The excess over August last year is nearly 17,000 on the month. For a holiday month the increase is all the more significant, and is particularly encouraging seeing that the growing demand has continued into the present month. The last two good months have reduced the adverse balance to 50,000 tons on the year to date compared with the corresponding period last year. Details :—

Port.	China Clay.		China Stone.		Ball Clay.		Total.	
	Tons. 1928.	Tons. 1927.	Tons. 1928.	Tons. 1927.	Tons. 1928.	Tons. 1928.	Tons. 1928.	Tons. 1927.
Falmouth....	—	160	—	—	—	—	—	160
Fowey.....	58,687	44,137	3,485	4,218	3,759	721	65,931	49,076
Looe	—	162	—	—	—	—	—	162
Par	3,666	5,484	639	534	—	—	4,305	6,018
Plymouth....	1,362	1,630	—	—	—	—	1,362	1,630
Penzance	613	620	—	—	—	—	613	620
Charlestown..	3,915	2,927	—	—	—	—	3,915	2,927
By Rail	3,899	3,313	—	—	—	—	3,899	3,313
August	72,142	58,433	4,124	4,752	3,759	721	80,025	63,906
Total 7 months	453,237	511,677	28,359	34,993	13,814	14,941	495,410	561,611
Total 8 months	525,379	570,110	32,483	39,745	17,573	15,662	575,435	625,517

China Clay Exports for August, 1928

A RETURN showing the quantities and values of the exports of China Clay, including Cornish or China Stone, the produce of Great Britain and Northern Ireland, from Great Britain and Northern Ireland, as registered in the month of August, 1928 :—

Country of Destination.	Quantity. Tons.	Value. £
Finland	2,867	4,389
Estonia	10	40
Sweden	2,708	5,182
Norway	3,603	8,890
Denmark	5	53
Poland	10	25
Germany	2,551	5,457
Netherlands	5,107	10,451
Belgium	8,651	15,685
France	3,828	7,786
Switzerland	42	82
Spain	1,365	2,883
Italy	2,700	6,316
Greece	5	31
Bulgaria	1	10
Turkey, Asiatic	2	7
Egypt	10	38
China	33	174
United States of America	27,280	57,495
Mexico	350	1,095
Brazil	22	83
Cape of Good Hope	3	50
Transvaal	1	7
Bombay, *via* Other Ports	1,046	4,569
Madras	30	173
Bengal	259	878
Australia	35	248
New Zealand	1	10
Canada	1,375	3,018
Irish Free State	5	23
Total	63,905	£135,148

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

Mortgages and Charges

*[NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.]*

BEDFORDSHIRE TILE CO., LTD., Leighton Buzzard.—Registered August 11, £100 debentures, part of £3,000; general charge. *£1,035. December 12, 1927.

BRITISH CAVITY BRICK AND TILE WORKS, LTD., London, W.C.—Registered August 18, charge, to Glyn Mills and Co., securing all moneys due or to become due to the chargees; general charge.

CROWN STAFFORDSHIRE PORCELAIN CO., LTD., Fenton.—Registered July 31, £1,500 debentures; general charge. *£3,000. April 13, 1927.

GLASTONBURY BRICK, TILE AND POTTERY CO., LTD.—Registered August 7, £1,350 mortgage, to R. Bath, Glastonbury, solicitor; charged on land and buildings at Glastonbury.

MACKENZIE BRICK AND TILE CO., LTD., London, S.W.—Registered August 25, £1,000 debentures; general charge. *Nil. December 31, 1927.

NEW CHELSEA PORCELAIN CO., LTD., Longton.—Registered August 7, £700 mortgage, to V. S. Gosling, 24, Lichfield Street, Wolverhampton, solicitor and another; charged on properties in High Street, Longton. *£700. July 14, 1927.

NORTH SOMERSET BRICK AND TILE CO., LTD., Midsomer Norton.—Registered July 25, £1,000 debentures; charged on land and buildings at Midsomer Norton with fixed machinery, etc., also general charge. *Nil. March 8, 1927.

PORTALS (JOHN ALLEN AND SONS), LTD., Ivybridge, paper makers.—Registered August 7, two mortgages, to bank; charged on properties at Ivybridge, Keighley, etc. *Nil. December 30, 1927.

RAINFORD POTTERIES, LTD.—Registered July 24, charge, to bank; charged on Rainford Potteries, Old Mill Lane, Rainford. *Nil. March 12, 1928.

SKEGNESS BRICK AND TILE CO., LTD.—Registered August 8th, £100 debentures, part of amount already registered; general charge. *£3,750. December 2, 1927.

TWYFORDS, LTD., Hanley, pottery manufacturers.—Registered August 18, trust deed, dated July 31, 1928, securing £69,722 10s., debenture stock; general charge. *Nil. July 13, 1928.

Satisfactions

BOWATER (W. V.) AND SONS, LTD., London, E.C., paper manufacturers.—Satisfaction registered, August 2, £10,000 registered July 29, 1926.

CROWN STAFFORDSHIRE PORCELAIN CO., LTD., Fenton.—Satisfactions registered August 22nd, £1,904 11s. 8d., outstanding July 1, 1908, £800, registered November 2, 1909, and £1,500, registered May 12, 1912.

FAREHAM BRICK AND TILE CO., LTD., Hants.—Satisfaction registered August 2, £11,000 registered March 13, 1925.

FONTLEY BRICK AND TILE CO., LTD.—Satisfactions registered August 2, £11,000 registered March 13, 1925, £3,000 registered June 9, 1925, and £6,800 registered February 24, 1927.

HILL, PALMER AND CO., LTD., London, E.C., paper manufacturers.—Satisfaction registered August 14, £100, part of amount registered September 25, 1924.

PORTALS, LTD., Whitchurch, Hants, paper manufacturers.—Satisfaction registered August 17, £50,000, part of amount registered April 8, 1921, etc.

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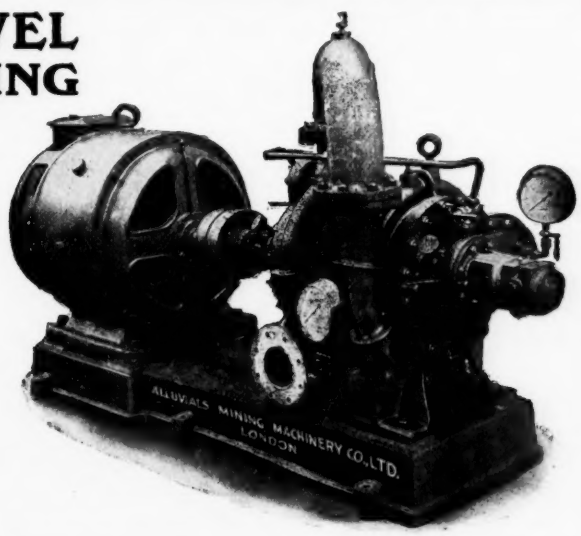

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Catalpo, Ltd., London.
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English China Clays, Ltd., St. Austell.
Fox, Roy & Co., Plymouth.
Grose & Stocker, Stoke-on-Trent.
Lovering, J., & Co., St. Austell.
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The China Clay Trade Review

The Official Organ of the China Clay Industry and the only Journal specially devoted to its interests. Published in the third issue of "The Chemical Age" each month.

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China Clay Export Prospects

HAVING regard to the unprecedented conditions which have prevailed in the commercial world since 1914, and the effect these have had upon the annual business done in the China Clay trade, it is natural that some producers should be raising the question as to whether the industry will ever get back the normal pre-war volume of business. These doubts were expressed by home China Clay producers as far back as 1921, and though things have improved considerably since then, the question is still canvassed and discussed. Last year the volume touched the pre-war figure, but this was due to an abnormal demand at the year-end.

Getting Back Pre-war Volume

If the falling-off of trade which has been experienced since the war had come about under normal conditions, there would have been some reason for the fear entertained in some quarters that the return of business to pre-war volume will never be experienced again. We are disposed, however, to accept the opinion expressed by those producers who recognise that the falling-off of trade since the war has been entirely due to the extraordinary circumstances produced by the war. and that as these give place to more normal conditions the export trade will revive again. In the last two or three years since the Dawes Plan was introduced to apply to the reparations question, it is gratifying to note the growing resumption of imports of China Clay to our former European customers, both Allied and ex-enemy, especially Germany, whose northern industrial area is accessible to our producers on as favourable terms as it is to the competing clays of Czecho-Slovakia. Connections of home China Clay firms which were broken off during the war, especially with enemy countries, have been resumed, and old business is being gradually weaned back for our products.

Conflicting Views

It has been pointed out that the tendency is for a very much greater demand in the near future for those commodities in which China Clay is largely used as a raw material, and that as the disposition of manufacturers is to use more instead of less China Clay, especially in the manufacture of paper, the likelihood is that the requirements of these manufacturers will eventually become greater than in the pre-war period.

Against this it is pointed out by those producers who take a less cheerful view of the future that some countries, notably America, France, Germany, Belgium, and Italy, are at present using more of their own domestic clays, and clays of neighbouring countries, than they ever did before, and that with the growing extent to which these foreign clays are used, so much less of our own product will be required. In answer to this view, the more optimistic producers of British China Clays emphasise the fact that countries now using clays which are substitutes for, and not in any way equal to, our clays, are using them, not because they prefer them, but because the present conditions on the Continent are not yet comparable to those that prevailed before the war.

Export Advantages

Another point which has been referred to many times when considering this important question of export trade, is that under normal conditions British China Clay can be placed on the markets of the world, taking quality for quality, at competitive prices which are distinctly in favour of our own product. Statistical evidence of this is seen in the huge quantities purchased by many countries before the war, which it may be reasonably inferred they would not have purchased if their own clays, both in quality and prices, had been capable of meeting the requirements of their manufacturers, although admitting, of course, the development that has ensued in recent years.

First Quality Goods Demand Best Raw Materials

Perhaps the most important fact which should be borne in mind both by our own China Clay producers and our own manufacturers of commodities in which China Clay is one of the essential constituents, is that no amount of adaptation and manipulation can produce first quality articles from inferior raw materials. For instance, users of newsprint who succumbed to the offers which were made by German paper makers were not long in discovering that the supplies obtained were far inferior to their pre-war product. The same inferiority in the finished product is apparent in several other manufactures of Continental origin, in the manufacture of which inferior raw materials have had to be used.

The manufacture of goods lower in quality than foreign customers have formerly been in the habit of buying, may suit the book of many foreign manufacturers during a period of stringency, but as soon as conditions more nearly approximate to those prevailing before the war, the latter will be quick to return to the better and more suitable raw materials, including China Clay, without which really first-rate goods cannot be manufactured.

Producers Views Summarised

We may therefore summarise the opinions expressed by China Clay producers of large export experience thus:

(1) That the reason why foreign countries are using other raw materials rather than British China Clays is due to conditions produced by the war.

(2) That they are not using these substitutes because they like them, but because for the time being the substitutes suit their economic circumstances.

(3) That the effect of the use of these substitutes is that they are turning out goods of quality inferior to those which they have been accustomed to make, and that they will return to the manufacture of these better class goods when circumstances permit.

(4) That in the meantime the opportunity is offered for our home manufacturers to supply those better class markets which their foreign rivals formerly supplied.

(5) That the natural increase in the normal demand for those commodities in which China Clay figures as a raw material should in the future be such as will call for as great a supply of China Clay as in pre-war years, if not greater.

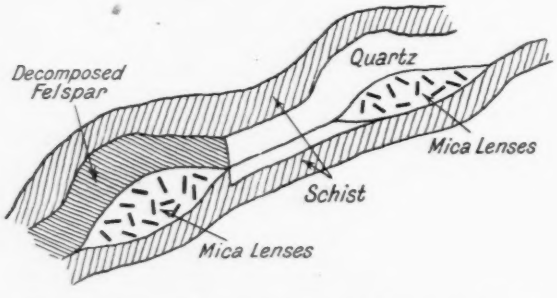
Basic Industrial Minerals. (I.)—Mica

By G. Malcolm Dyson, Ph.D., A.I.C.

FROM the standpoint of the petrologist, the term "mica" covers a very large group of minerals, all of which are acid silicates of varying complexities, and which have certain physical characteristics, in particular, exceptionally marked cleavage planes, in common. Commercially there are two fundamental classes of micas: muscovite, or potash micas, whose chemical formula approximates to $H_2KAl(SiO_4)_3$; and phlogopite or magnesium mica, which is in many cases a complex silicofluoride approximating in composition to $HK(MgF)_3$, $Mg_3Al(SiO_4)_3$. In addition there are several other micas which are of no inconsiderable interest to chemical industry; among these may be mentioned lepidolite or lithia mica, which contains up to 5 per cent. of the comparatively rare element lithium. Lepidolite has usually a rose-red or lilac tinge, which is due to the presence of traces of manganese silicates; whilst a complex iron-lithium mica, known as zinnwaldite, is mined in the Erzegebirg as a source of lithium. The well-known mineral roscoelite is, in reality, a vanadium mica, and contains up to 14 per cent. of vanadium. It is mined in the Colorado district, where its vanadium content is extracted. In addition, there is a sodium mica of no importance known as paragonite, and a whole series of ferriferous phlogopites known as biotites, which occur widely-distributed throughout many geological formations.

Production of Mica

To be of value commercially, mica must be obtained in fairly large homogeneous slabs, which can be readily split into leaves. Such slabs are invariably termed "books." The "books" are usually found overlaying a schist stratum and are often themselves overlaid by quartz or felspar; in addition, the veins of "book-bearing" mineral are neither



MICA-BEARING FORMATION IN THE ALUKDEAH MINE.

continuous nor of uniform thickness, but consist of intermittent patches, so that, in mining, one must proceed from one "lens," as it is termed, to another, more or less by guesswork. This makes mica mining a matter requiring considerable patience. A typical "lens" formation is shown in the sketch above, which represents the strata in the celebrated Alukdeah mine, where books several feet in length are a common occurrence. Canada, the U.S.A., and India, produce between them over 90 per cent. of the world's supply of mica, there being no deposits of good book mica in this country. There is also much mica in Australia, but at the present time it is not worked to any extent. The Bureau of Commerce figures for mica production are given below:—

Mica Production

COUNTRY.	1919	1920	1921	1922	1923	1924	1925
British Empire—							
N. Rhodesia ...	—	1	—	—	—	—	—
S. Rhodesia ...	5	87	76	59	81	134	130
Tanganyika ...	(a)	27	3	11	32	55	68
S. Africa	9	6	2	1	14	892	1,439
	(2)	(1)	(–)	(–)	(3)	(178)	(288)
Canada	2,459	1,966	1,047	2,900	3,147	3,653	3,153
	(344)	(225)	(177)	(176)	(405)	(607)	(389)
Ceylon	8	15	5	1	1	—	—
India	2,955	3,826	1,547	2,157	4,165	3,505	4,985
Australia	1	1	—	4	—	2	4
Empire totals	5,437	5,929	2,680	5,223	7,440	8,241	9,779
	(3,315)	(4,233)	(1,808)	(2,408)	(2,687)	(4,481)	(5,864)
Guatemala	5	4	a	a	a	a	a
Mexico	10	4	a	a	a	a	a
Norway	95	31	2	1	—	—	—
Roumania	71	133	a	a	—	—	—
Russia	a	a	a	8	a	a	a
Spain	7	5	2	—	3	a	a
Sweden	—	—	—	8	5	4	a
Madagascar	18	49	152	91	162	274	282
U.S.A.	3,599	5,862	2,632	6,411	8,112	4,856	9,457
Argentine	143	269	154	63	100	118	117
Brazil	152	67	45	66	55	78	a
Korea	—	—	11	19	424	582	a
Japan	—	—	—	15	11	23	a
Foreign totals ...	4,100	1,424	2,986	6,682	8,872	5,935	9,856
	(1,191)	(1,314)	(688)	(752)	(1,680)	(1,730)	(1,200)
Grand totals	9,537	12,353	5,669	11,905	16,312	14,172	19,635
	(4,506)	(5,547)	(2,496)	(3,160)	(6,368)	(6,211)	(7,064)

"a" signifies that no data are available.
Where the total output is not wholly "book" mica, the output of this substance is added in brackets.

Properties and Uses

It is the perfect cleavage and transparency of mica, together with its toughness and remarkable heat and electrical insulating properties, that make it so valuable a commercial article. The books of mica are split by expert labour into thin laminæ, for the thickness of which 0.001 in. is aimed at, and very often attained. The marketing of the finished and trimmed leaves is a matter that is much more easily accomplished by a group or syndicate than by the small producer, since the price obtained depends on the "evenness" of the parcel. With a central grading station supplied by a number of producers this may be done easily, whereas the small producer is often compelled to dispose of parcels of "mixed" at a lower price.

There are slight physical differences between the various types of micas which, although apparently insignificant in themselves, cause differences in the properties of the product which have a considerable effect on the price obtained. The best mica for insulating and general electrical purposes is that from India, often known as "Bengal ruby"—a survival from the time when the principal producing stations were in the province of Bengal. Its uniformity and high specific inductive capacity make this type of mica eminently suited for the manufacture of electrical condensers. Carolinian mica has a green tinge and is much harder than the Indian red mica; it is little affected by rapid changes in temperature and finds considerable use for the fitting of furnace sight holes, etc., where temperature plays a great part. For gramophone diaphragms the Georgian brown mica is preferred, since it gives laminæ of almost perfect flatness. In some cases the hardness of the mica used is a very important factor, as, for example, in the manufacture of commutators for d.c. motors. Here, it is essential that the insulating material should wear down at the same rate as the copper of the segments, but ordinary mica is somewhat harder than copper and is therefore unsuitable for this purpose. There exists, however, a Canadian deposit known as "silver-amber mica" (an altered phlogopite) which has an edge hardness exactly the same as that of electrolytic copper; it is used exclusively for commutator manufacture.

Ground Mica

Ground mica is in considerable and steady demand for the manufacture of roofing materials, wallpaper, and as a mineral filler, the various uses and the percentage of the output that they account for being given in the table below:—

Roofing Materials	60 per cent.
Wallpaper	21 ,, ,,
Tyres	8 ,, ,,
Frosting Fancy Goods	3 ,, ,,
Insulators	3 ,, ,,
Mineral Filling	3 ,, ,,
Lubrication	2 ,, ,,

The grinding may be done dry in the hammer type of pulveriser, followed by screening and classification by air flotation, but the dry ground product is not so valuable as that which has been ground wet, especially for wallpaper patterning, since it has less "glitter." Wet grinding is usually done by beating, since grinding by the more usual methods is impossible. The tubs for grinding are wooden cylinders, the bottom consisting of wooden blocks with the

end-grain exposed to resist abrasion. The beater is a wooden circular slab which almost fills the cross section of the tub. The charge to each tub is about 400 lb. of mica trimmings, which are beaten for eight hours. The classification is performed by water, coarse particles settling in the first tank and being returned to the beaters, while the finer particles pass on. It has been noticed that settling is much more rapid in wooden tanks than in concrete tanks, an observation which led to the discovery that the trace of alkali from the concrete had a considerable deflocculating action on the mica particles, a phenomenon which is also observed with China Clay. It has, therefore, become usual to add about 0·25 per cent. of a flocculating agent (usually alum or aluminium sulphate). About 90 per cent. of the mica will settle out in an hour or two without the use of a flocculator, but the remainder is still in suspension after 72 hours; it is at this stage that the flocculating agent is added.

Micanite and "Synthetic" Mica

The high price and comparative shortage of good insulating mica for electrical purposes has led to numerous attempts to replace mica by a synthetic product, and also to utilise the smaller and imperfect sheets by a building-up process. It is the latter that has been the more successful, and the product Micanite is extensively used in the electrical industry. Micanite is built up by laying a number of fragments of mica on a sheet of oiled paper, and covering them by a second layer arranged in such a way that the cracks in the first layer are covered by good mica in the second. The layers are separated by a thin coating of good shellac dissolved in spirit. Many layers are built up in this way and the pile finished off with oiled paper, gently heated to evaporate the spirit, and then pressed hydraulically at 150 lb./sq. in. in a press heated to 150° C. After a short time the press is cooled off by cold water circulation, without, however, relaxing the pressure. In this way a sheet of Micanite is built up which contains less than 2 per cent. of shellac, but which forms a homogeneous and electrically perfect material. True synthetic mica has been prepared by melting, at 1,500° C., seven parts of window glass, three parts of aluminium fluoride and five parts of magnesium potassium silicofluoride, but it does not appear that this material can replace the natural product.

Vitrification of Ceramic Bodies

Work of American Bureau of Standards

At the Columbus branch of the U.S. Bureau of Standards of an investigation of the boundary of the field of mullite in the $K_2O.Al_2O_3SiO_2$ system is being made. In so far as possible, minerals are being used in making the melts. The general procedure has been to mix the proper proportions of minerals with dextrin, making a paste which is forced through a glass tube drawn down at one end to about 2 mm. diameter. This "spaghetti" is then melted in an oxy-gas flame and the beads quenched in water or mercury. The melt is examined microscopically for a crystal phase and the index of the glass measured. The results are then plotted on a three-component diagram.

Melts containing varying amounts of orthoclase, kaolin, and flint (silica) were first made and examined. Mullite crystals were found to occur in melts containing at least 30 per cent. kaolin, those with less being composed almost entirely of glass. There is an almost constant variation in the indices of the glasses ranging from 1·48 with 10 per cent. kaolin to 1·54 with 90 per cent. The amount of mullite crystals increases with the index of the glass. The crystals occur as fibres showing position elongation: indices are $\omega = 1{\cdot}64$, $\varepsilon = 1{\cdot}66$.

Leucite-kaolin melts show practically the same results as do orthoclase-kaolin melts. Mullite and alumina have been used with orthoclase and leucite. The primary mullite crystals appear in all the melts containing up to 90 per cent. mullite under the conditions of experimenting. When alumina is introduced the mullite crystals appear in melts containing as much as 50 per cent. The appearance of beta corundum near the alumina end of the diagram has been very interesting.

An effort is now being made to make a composition of material corresponding to kaliophilite, $K_2O.Al_2O_3.2SiO_2$, to be used with kaolin, mullite, and alumina in locating the extent of the mullite field in that direction, though as yet the extreme volatility and solubility of potash have prevented success. No detailed work has been done along the boundary lines, as a reconnaissance of the whole field is first being made. Temporary factors as well as volatilisation will probably have to be taken into account in later work.

Death of Mr. H. S. Andrew

Secretary of English China Clays

The death occurred on Saturday, October 6, at St. Austell District Hospital, of Mr. Henry Stephen Andrew, of English China Clays, Ltd. He was a son of the late Mr. W. Andrew, of Truro, and, like the latter, was associated at one time with the firm of Lake and Son, Moresk Mills, Truro. On leaving Truro he went to Tywardreath, where he was associated with the Beaver Mills. Later he was appointed secretary to a firm of China Clay merchants at Plymouth, where he remained for some years. Mr. Andrew came to St. Austell in 1919, following the amalgamation which absorbed the Clay firm with which he was associated. He was made a director of English China Clays, Ltd., and became secretary to the company. Mr. Andrew leaves two sons, of whom one is in the offices of English China Clays, Ltd., while the other is a surveyor in Warwickshire.

At the funeral, which took place on Tuesday, October 9, there were present many representatives of the China Clay industry.

Study of Clay in Bodies

A United States Investigation

The China Clay investigation in progress at the Columbus branch of the United States Bureau of Standards includes a study of the clays in bodies as well as a study of the clays alone. The composition of one set of bodies is 50 parts potter's flint and 50 parts clay, while the other is 50 parts clay, 30 potter's flint, and 20 feldspar. It is believed that the real reasons for the differences in the clays will be brought out more clearly by studying the reactions when in bodies as well as when treated individually. The general purpose of the investigation is to compare British and American China Clays, but as yet only the British have been studied. Of these, seventeen commercial brands are being used. During the past few months the work on the bodies composed of potter's flint and clay was carried out and is nearly completed.

Each of the clays was made up with an equal weight of potter's flint into a body; the size of specimens and procedure of making and testing following closely the specifications of the American Ceramic Society. The properties evaluated on the unfired bodies were those of volume shrinkage, shrinkage water, pore water, water of plasticity, bulk specific gravity, slaking time, and modulus of rupture. On the fired bodies values for volume shrinkage, porosity, bulk specific gravity, and modulus of rupture wese determined at seven different temperatures—namely, cones 3, 5, 8, 11, 14 18 and 23.

The various bodies have so nearly the same value for any one property that for the present purpose averages only are given. To show the effect of the flint, general averages for the clays alone are also given.

Dry Properties of Clays and Bodies

	Properties.						
Material.	Volume Shrinkage. per cent.	Shrinkage Water. per cent.	Pore Water. per cent.	Water of Plasticity. per cent.	Bulk Specific Gravity.	Slaking Time. hours.	Modulus of Rupture. lbs./in.
Clays alone ..	18·6	11·6	29·8	41·3	1·46	7·7	88·0
Bodies	11·6	7·1	20·4	27·5	1·64	6·6	46·6

Fired Properties of Clays Alone

	Cone.						
Property.	3	5	8	11	14	18	23
Volume shrinkage.....	20·0	26·3	32·5	41·7	48·8	48·5	48·5
Porosity	40·3	35·9	29·0	17·5	3·9	1·2	1·0
Bulk specific gravity	1·60	1·75	1·91	2·17	2·45	2·50	2·50
Modulus of rupture	—	—	2,200	3,000	4,000	5,500	6,00

Fired Properties of Bodies

	Cone.						
Property.	3	5	8	11	14	18	23
Volume shrinkage.....	7·3	8·4	9·6	12·2	17·8	26·2	31·1
Porosity	34·9	34·3	33·7	33·7	26·4	15·7	2·7
Bulk specific gravity	1·64	1·66	1·68	1·72	1·83	2·06	2·21
Modulus of rupture	35	450	765	890	1,350	2,000	2,600

China Clay Notes and News

Finnish Markets for China Clay

In a recent issue of *Finnish Trade* there appeared a survey of the markets for chemicals and papermaking materials in Finland, especially in relation to British products. Explaining why imports from Great Britain are comparatively small, Dr. C. W. Chydenius says of China Clay: It is produced in England, chiefly in Cornwall, and in Germany. It is principally used in the paper industry as a filling material, and in the manufacture of porcelain. Owing to the cheapness of this article, it cannot bear the high costs of transport in Germany from the place of production to the place of shipment and costs of transhipment arising there. The fact that the deposits in Cornwall are so favourably situated as regards shipping ports has enabled England to retain her position as chief supplier of this article. Owing to its extreme suitability for special purposes, certain quantities of German clay are imported for the manufacture of glass and china. Thanks to higher prices of imported raw materials, the Finnish talc industry has developed and gained ground at the expense of the British China Clay, so that imports of this article will be lower during the current year than they were last year. Another fact which has had certain influence on imports is the low price obtained for wood pulp, which causes the manufacturers of paper to use more wood pulp and less filling material. The rigorous American regulations relating to the ash content of imported paper have also restricted the use of filling material. Last year, the total imports of China Clay amounted to 20,993,616 kgs., valued at Fmks. 9,531,343. England's share of these imports was 20,083,224 kgs., as against 704,066 kgs. falling to the share of Germany and 168,843 kgs. coming from Czechoslovakia.

Clay-Craft Chemistry

Writing on the subject of chemistry as applied to manufactures in which clay is used, Mr. G. B. Hunter says that clay is said to be a substance of secondary origin, that is to say, derived from the decomposition of primary rocks. Broadly speaking, it is a compound of aluminium oxide, silica, and water. Besides these main constituents, there are others of minor note such as lime, iron, manganese, and mica, which, present in exaggerated proportions in clay, render it useless to the manufacturer.

More important to the "ceramic" or clay craftsman than the chemical properties are the physical properties of clay, the chief of these being plasticity. Nearly all clays when wet are plastic, that is to say, are easily changed into different shapes under pressure, remaining in these forms when the pressure is relaxed. Among other important properties of clay are the texture or fineness, which is a function of the sizes and distribution of the particles of matter, and shrinkage, due to fire or air porosity, that is to say, the capacity of clay for absorbing air and moisture.

Research Work of Chemists

Thanks to the extensive work of chemists during the present century, the ceramic industry has made enormous progress. So numerous and so various are the uses of clays at the present day that it is hardly possible for any of us to imagine modern civilisation without this substance. Besides its importance in the manufacture of bricks, tiles and earthenware, clay enters into the soap and paper industry. It is also extensively employed in the preparation of pigments, paints, ultramarine, and alum. The contribution of physical chemistry has enabled the ceramic manufacturer to determine more accurately the properties of numerous varieties of clay which had formerly been used empirically by ancient craftsmen.

Cornwall's Commercial Epochs

The first commercial epoch of Cornwall, the ancient epoch according to a recent writer, commenced with the arrival of the Phoenicians in search of tin about the year 1500 B.C., while the second sprang from the discovery by Cookworthy of China Clay and China Stone in the St. Austell district. A high degree of ceramic proficiency was attained by the Moors after their conquest of Spain. Among other examples of their unique art was the famous Alhambra at Granada, the Alcazar at Selville, and the Palace of the Portuguese Kings at Cintra. These great buildings were lavishly and magnificently embellished in tile work, and in these and other decorations of the Hispano-Moresque Palaces the principal ingredient was tin obtained from Cornwall.

When one comes to the modern epoch, the part played by Cornwall is not that of manufacturing but that of supplying the materials for manufacture, and this task, thanks to the discovery of China Clay, it is enabled to do so on a scale that could not have been imagined in the olden days. Pottery making is fairly distributed throughout the country, but its principal seat is of course in North Staffordshire, the potteries of which are known throughout the world. The district in which the industry is concentrated has been familiarised by Arnold Bennett as "The Five Towns," although the number should really be six. It was because materials were on the site or close to it that Staffordshire became the British pottery centre. They had abundant measures of marl clay and coal, and other ingredients, such as salt, lead, and felspar, could be obtained within the county or from Derbyshire, which adjoins it. But for supplies of China Clay, Ball Clay, and China Stone they had to look to Devon and Cornwall. The great potters, Elers, Josiah Wedgwood, Whieldon, Astbury and others made the best use of materials which were obtainable, and by perseverance and artistic skill raised a crude local occupation to an industry and art of national importance.

Specialised Uses for Colloidal Clay

It is generally supposed that China Clay is used chiefly, if not entirely, in the manufacture of pottery, and that it has few other uses. In fact, only a very small proportion of China Clay is utilised by the pottery manufactures, and it plays a far more important part in other forms. It is, for instance, employed very extensively in the making of paper of all grades, as bleachers and fillings by textile manufacturers, and in the manufacture of buttons, linoleum, plaster of paris, disinfectants, and many other things. Collodial clay, which is a highly refined kind of China Clay, forms a constituent in the making of rubber products, pencils, paints, distempers, and printing inks, and is the basis of many tooth powders and cosmetics. It is also used in medicine, as it is possessed of adsorbent properties which render it valuable in the treatment of intestinal troubles.

Kaolin in the Dutch East Indies

In his recent report on the economic situation of the Netherlands East Indies, the British Commercial Agent at Batavia gives the following particulars regarding certain of the natural resources of these islands. With regard to China Clay deposits, the question of the local manufacture of cheap china-ware for sale to the native population has for some time past been given considerable attention by the officials of the Division of Industry at Buitenzorg, who are prepared to grant anyone disposed to put capital into such a venture all the information at their command and any technical assistance available. The principal requirement for the profitable production of a pottery industry is an adequate supply of suitable raw material. Kaolin has been found in commercially exploitable quantities near Trenggalek in the Kediri residency of Java, the concession rights for which are held by a Dutch subject. Engineers of the mining service have recently been engaged in prospecting for further China Clay deposits, and it is now announced that suitable material has been located in the Island of Madoera and in yet another area of Kediri.

Further Outlets for China Clay

A China Clay producer writes us as follows: Most China Clay producers or firms connected with the China Clay trade are aware that for some time past the demand for China Clay has not been up to the usual standard. They also know that if the demand for China Clay increased considerably, this demand could be supplied. Could not the China Clay producers find more uses for China Clay? If paper makers found that China Clay was a good filler for paper, and rubber and paint manufacturers found it was useful for their products, could not the clay producers devote themselves to finding still other outlets for their goods? Did not the linoleum manufacturers find out that China Clay was a satisfactory filler for this process? In a nutshell, if one further use for China Clay could be found such as paper making, where about 400,000 tons are used annually (and no doubt it could be, with proper research), China Clay producers would all be working "full speed ahead."

Shipping and Export News of the Month

We give herewith latest particulars relating to arrivals and sailings of ships engaged in the China Clay trade, at the principal British clay ports. Registered exports of China Clay, with countries of destination, and other shipping and export matters are dealt with.

Fowey Shipping—September, 1928

Arrived.	Name.	Sailed.	Destination.
September 1,	S.S. *Burrington Combe*	September 3,	Bristol
September 1,	S.V. *Christian*	September 6,	Sodertelje
September 3,	S.S. *Marta*	September 3,	Gothenburg
September 3,	S.S. *Gouwestroom*	September 6,	Amsterdam
September 3,	M.V. *Regina*	September 8,	St. Keverne
September 3,	S.S. *Gouwestroom*	September 6,	Amsterdam
September 4,	S.S. *Farfield*	September 5,	Grimsby
September 5,	S.S. *Westdale*	September 7,	Rouen
September 5,	M.V. *Mayblossom*	September 11,	Porthoustock
September 5,	S.S. *Primrose*	September 7,	Larne and Preston
September 5,	S.S. *Joffre Rose*	September 8,	Preston
September 6,	S.S. *Mersey*	September 8,	Ridham
September 6,	S.S. *Hampshire Coast*	September 8,	Liverpool
September 7,	S.S. *Fermain*	September 9,	Pasages
September 9,	M.V. *Mars*	September 11,	Hamburg
September 9,	S.S. *Ardgantock*	September 12,	Antwerp
September 9,	S.S. *Snofrid*	September 11,	Karlskrona
September 9,	S.S. *Hayle*	September 12,	Weston Pt.
September 11,	S.S. *Torpoint*	September 11,	Barry
September 11,	S.V. *Hilda*	September 16,	Hull
September 11,	S.S. *Pansy*	September 12,	Leith
September 12,	S.S. *Blush Rose*	September 14,	Rouen
September 12,	S.S. *Sturdee Rose*	September 13,	Brussels
September 12,	M.V. *Vesta*	September 13,	Munkedal
September 12,	S.S. *Portland Maru*	—	Portland Me.
September 13,	S.V. *Else*	—	Reval
September 13,	S.S. *Guelder Rose*	September 14,	Runcorn
September 13,	S.S. *Colon*	September 15,	Genoa
September 13,	S.S. *Edenside*	September 14,	Sunderland
September 14,	S.S. *Mona*	September 15,	Antwerp
September 14,	S.V. *Theodora*	September 14,	Mevagissey
September 14,	M.V. *Shamrock*	September 15,	Plymouth
September 14,	S.V. *Jane Banks*	September 15,	Glasgow
September 14,	S.V. *Waterwitch*	September 19,	Weston Pt.
September 14,	S.S. *Torfrid*	September 25,	Odense
September 15,	S.S. *Levenbridge*	September 24,	Philadelphia
September 15,	S.S. *Skagatind*	September 21,	Sheboygan
September 15,	S.S. *Clan Macbean*	September 21,	Bombay
September 16,	S.S. *Joffre Rose*	September 25,	Bo'ness
September 16,	S.S. *Mersey*	September 25,	Ridham
September 16,	S.S. *Fyrileif*	September 22,	Wiborg
September 16,	S.S. *Onyx*	September 21,	Jersey
September 17,	S.S. *Shamrock*	September 18,	Plymouth
September 18,	S.S. *System*	September 21,	Antwerp
September 19,	S.S. *Poleric*	September 27,	Boston, U.S.A.
September 19,	S.S. *Gouwestroom*	September 26,	Amsterdam
September 19,	S.S. *Garthclyde*	September 21,	Gravelines
September 19,	S.S. *Beauley Firth*	September 22,	Antwerp
September 19,	S.S. *Abington*	September 21,	Liverpool
September 19,	S.S. *Glencregagh*	September 22,	Rouen
September 19,	S.S. *Brier Rose*	September 27,	Weston Pt.
September 19,	S.S. *Primrose*	September 22,	Rouen
September 20,	M.V. *Lydia Cardell*	September 25,	Weston Pt.
September 21,	M.V. *Mercurious*	September 25,	Wargon
September 22,	S.S. *Blush Rose*	September 29,	Weston Pt.
September 22,	S.S. *Blanche*	September 25,	Charlestown
September 22,	S.S. *Haig Rose*	September 28,	Weston Pt.
September 22,	M.V. *Frida Both*	September 30,	Wiborg
September 23,	S.S. *Robrix*	September 26,	Grimsby
September 23,	S.S. *Wearbridge*	October 3,	Philadelphia
September 24,	S.S. *Florentino*	September 27,	Genoa
September 26,	S.S. *Oak*	September 28,	Garston
September 26,	S.V. *Vera*	September 29,	Charlestown
September 27,	S.S. *Wild Rose*	September 29,	Preston
September 27,	S.S. *Mount Charles*	September 29,	Par
September 28,	S.S. *Annchen Peters*	October 1,	Harburg
September 28,	S.S. *Guelder Rose*	September 28,	Newport
September 28,	S.S. *Brier Rose*	October 1,	Manchester
September 28,	S.V. *Englishman*	October 6,	Runcorn
September 29,	S.S. *Aslak*	October 2,	Riga
September 30,	M.V. *Osterschelde*	October 2,	Sandvikin

Charlestown Shipping—September, 1928

Arrived.	Vessel.	From.	Sailed.	Destination.
August 31	S.V. *Ability*	Par	September 1,	Snodland.
August 31,	S.V. *Cetus*	Plymouth	September 6,	London.
September 1,	S.S. *Jolly Laura*	Truro	September 3,	Gravesend.
September 3,	M.V. *Katie*	Britton Ferry	September 20,	Runcorn.
September 3,	S.V. *Irish Minstrel*	Falmouth	September 6,	Runcorn.
September 6,	S.V. *Elsa*	Cardiff	September 15,	Nantes.
September 11,	S.V. *Alf. Everard*	Plymouth	September 18,	Snodland.
September 13,	S.V. *Alert*	Truro	September 14,	Granton.
September 14,	S.S. *Coniscrag*	Plymouth	September 15,	Antwerp.
September 16,	M.V. *Ewigkeit*	Plymouth	September 17,	Hamburg.
September 18,	S.S. *Knowlgrove*	Truro	September 19,	Tayport.

China Clay Exports, September, 1928

A RETURN showing the quantities and values of the exports of China Clay, including Cornish or China Stone, the produce of Great Britain and Northern Ireland as registered in the month of September, 1928, is as follows :—

COUNTRY OF DESTINATION.	QUANTITY. Tons.	VALUE. £
Finland	602	940
Latvia	346	596
Sweden	2,403	6,378
Norway	275	591
Denmark (including Faröe Islands)	49	182
Germany	2,531	5,727
Netherlands	4,950	11,638
Belgium	2,202	5,207
France	2,512	4,854
Switzerland	66	198
Spain	1,445	3,555
Italy	2,523	6,307
Greece	102	207
Turkey, Asiatic	1	3
Siam	10	54
China	11	64
United States of America	15,106	33,733
Argentine Republic	50	195
Irish Free State	5	22
Nigeria (including British Cameroons)	—	1
Cape of Good Hope	—	3
Natal	1	4
British India, via Bombay	253	1,194
Via Madras	5	25
Via Bengal, Assam, Bihar and Orissa	168	640
Australia	40	220
Canada	236	840
Total	35,892	83,378

China Clay Imports, August, 1928

A RETURN showing the quantities and value of China Clay, including China Stone imported into Great Britain and Northern Ireland as registered in the month of August, 1928, was as follows :—

COUNTRIES WHENCE CONSIGNED.	QUANTITIES. Tons.	VALUE. £
Germany	10	96
Channel Islands	220	275
Total	230	371

These figures were issued by the Board of Trade too late for inclusion in the September number of THE CHINA CLAY TRADE REVIEW.

China Clay Imports, September, 1928

A RETURN showing the quantities and values of China Clay (including China Stone) imported into Great Britain and Northern Ireland as registered in the month of September, 1928, was as follows :—

COUNTRIES WHENCE CONSIGNED.	QUANTITIES. Tons.	VALUE. £
Germany	22	171
U.S. America	62	342
Total	84	513

September Deliveries Down

CONTRARY to expectations, the business done in September did not maintain the progress made in August, being just under 5,000 tons down. The biggest drop was in China Clay, Ball Clay deliveries suffering to the extent of only 750 tons. China Stone deliveries were up by 1,550 tons. On the nine months compared with the corresponding period last year there is a balance on the aggregate trade in favour of last year of 64,995 tons, the only section in which an increase is shown being Ball Clay, the excess tonnage being under 2,000. Details of deliveries are as follows :—

Port.	China Clay. Tons. 1928.	China Clay. Tons. 1927.	China Stone. Tons. 1928.	China Stone. Tons. 1927.	Ball Clay. Tons. 1928.	Ball Clay. Tons. 1927.	Total. Tons. 1928.	Total. Tons. 1927.
Fowey	49,934	66,250	5,071	4,415	2,999	3,172	58,004	73,837
Par	5,509	2,830	409	94	—	—	5,978	2,924
Charlestown..	2,834	6,259	—	—	—	—	2,834	6,259
Plymouth....	2,805	1,010	—	—	—	—	2,805	1,010
Penzance ...	1,154	1,468	—	—	—	—	1,154	1,468
Falmouth ...	170	530	—	—	—	—	170	530
By rail	4,251	4,081	—	—	—	—	4,251	4,081
September ..	66,717	82,428	5,480	4,509	2,999	3,172	75,196	90,109
8 months	525,379	570,110	32,483	39,745	17,573	15,662	575,435	625,517
Total 9 months	592,096	652,538	37,963	44,254	20,572	18,834	650,631	715,626

Clay in the United States

Sales, Imports, and Exports in 1927

THE quantity of clay sold by producers in the United States in 1927 amounted to 3,849,176 short tons, valued at $13,697,159, or $3·56 a ton, according to a statement made public by the United States Bureau of Mines, Department of Commerce. These figures show a decrease of 3 per cent. in quantity and value compared with 1926. They represent only clay sold as clay or mined under royalty, and do not include the much greater quantity of clay that was burned into clay products by the producers themselves from their own property. The leading five States in the order of the quantity of clay sold were Pennsylvania with 23·3 per cent. of the total quantity, Missouri with 10·8 per cent., Ohio with 8·4 per cent., New Jersey with 8·1 per cent., and California with 7·5 per cent. The data were collected direct from producers in 43 States and in co-operation with the State Geological Surveys of Alabama, Florida, Georgia, Illinois, Iowa, Maryland, Michigan, Missouri, New Jersey, New York, North Carolina, Texas, Virginia, Washington, and Wisconsin.

Sales of Kaolin

The sales of kaolin, the clay that is used in making high-grade pottery and porcelain, as well as paper, oilcloth, and other products, and which is generally considered the highest grade of clay, amounted to 454,245 tons, valued at $3,809,834, an increase of 5 per cent. in quantity and 1 per cent. in value as compared with 1926. The clay of largest quantity and value is fire clay. The sales of fire clay in 1927 were 2,699,761 tons. This was 4 per cent. less than those of 1926, the year of largest sales. The value of the fire clay sold in 1927 was $7,719,725, a decrease of 5 per cent. as compared with 1926.

The imports of clay in 1927 amounted to 394,500 short tons, valued at $3,448,970, a decrease of 19 per cent. in quantity and value. Kaolin, or China Clay, constituted 86 per cent. of the total imports in 1927. Exports of clay in 1927 amounted to 99,384 tons, valued at $1,117,889, an increase of 11 per cent. in quantity and 13 per cent. in value as compared with 1926. Exports of fire clay amounted to 48 per cent. of the total.

CLAY SOLD BY PRODUCERS IN THE UNITED STATES IN 1926 AND 1927

Kind.	1926. Short Tons.	1926. Value, $.	1927. Short Tons.	1927. Value, $.
Kaolin	432,215	3,771,568	454,245	3,809,834
Ball Clay	112,195	867,500	119,763	913,976
Slip Clay	8,644	45,959	6,137	32,264
Fire Clay	2,819,346	8,119,323	2,699,761	7,719,725
Stoneware Clay	84,002	185,288	98,355	203,648
Miscellaneous Clay	510,796	1,115,951	470,915	1,017,712
Totals	3,967,198	14,105,589	3,849,176	13,697,159

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

Deeds of Arrangement

BUTLER, Hubert Oswald, Tourbieres de St. Laurent, Bayonne, France, and Langmoor Manor, Charmouth, brick and tile manufacturer. Dated September 20, filed September 26. Trustee, R. J. Brandon, 10, New Court, Carey Street, W.C., C.A. Secured creditors, £940; liabilities unsecured, £6,396; assets, less secured claims, £2,377.

Mortgages and Charges

*[NOTE.—The Companies Consolidation Act of 1908 provides tha every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.]*

FURNESS PAPER MILLS, LTD., Ulverston. Registered August 28, £15,000 mortgage, to Second Broadmount Trust, Ltd., 14, Waterloo Place, S.W.; charged on properties at Ulverston, etc. *£15,000. November 30, 1927.

HORTON KIRBY PAPER MILLS (1927), LTD. Registered August 29, £40,000 debenture, to Century Insurance Co., Ltd., 18, Charlotte Square, Edinburgh; charged to Horton Kirby Paper Mills, also general charge.

ILKESTON PORCELAIN CO., LTD. Registered September 4, £300 debenture, to Mrs. D. L. Oakley, The Litten, Amersham; general charge. *Nil. July 6, 1928.

CORRINGHAM BRICK AND TILE WORKS, LTD., London, W.C. Registered September 14, Trust Deed dated September 7, 1928, securing £10,000 debenture stock, etc.; general charge.

Satisfaction

BRACKEN (T. H.) AND CO., LTD., Leeds, paper manufacturers. Satisfaction registered September 20, £14,000, outstanding July 1, 1908.

History and Production of China Clay

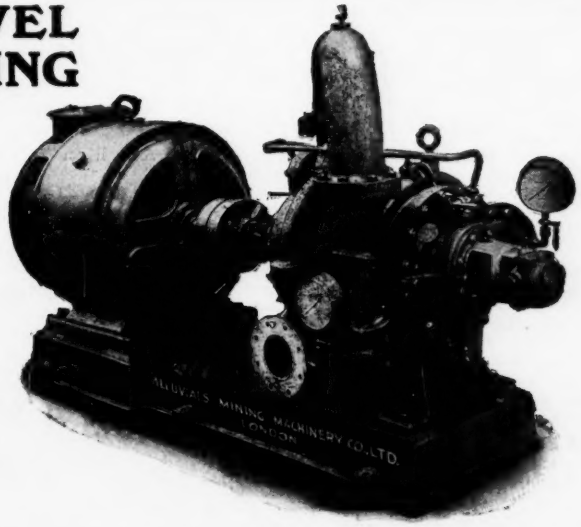
A Lecture at Plymouth

CHINA Clay products and their uses were the subject of a lecture by Mr. G. S. Clarke to the members of the Plymouth Rotary Club recently. He said that England was in a happy position as regards China Clay, for she could claim the best deposits in the world. Indeed, with increasing uses for the clay, it would seem that that was one way to prosperity. Most textile trades had to import their material, but Britain already had the raw material for this industry to hand. For refining into colloidal form no China Clays in the world could be found to equal the British, if only it came from the right source. The uses of China Clay were varied and numerous. Contrary to popular opinion, pottery formed quite a small percentage, most China Clay being used for paper manufacture, particularly art paper, and for newspaper and wallpaper. Another use was for medicinal purposes. Cookworthy discovered China Clay in Cornwall in 1768. A patent was taken out, and factories were established in Plymouth and Bristol. English pottery, therefore, really started in Plymouth, though the site of the factories had been lost, but owing to lack of coal Cookworthy had to move the factories nearer a supply of fuel. To-day it had been found that oil made a very effective substitute for coal, and here, said the lecturer, was Plymouth's chance to get back an industry with the mines so close to the town. Chemically, China Clay was the result of disintegration of granite rock, which was of crystalline structure. Surface action by weather, and action below the surface of the earth caused the hard rock to become a fibrous mass. Cornish Stone was partially granite, which contained felspar and remained as hard rock. It was graded for the market in its stages of weathering, and was ground and used as flux in the manufacture of pottery.

The China Clay Trade Review

The Official Organ of the China Clay Industry and the only Journal specially devoted to its interests.

PIONEERS IN GRAVEL AND SAND PUMPING



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AERIAL ROPEWAYS.
British Ropeway Engineering Co., 7, Mincing Lane, London.

AUCTIONEERS.
Hancock & Sons, Sydney Place, St. Austell.

BAGS AND LINERS (COTTON).
Feltham, W. H., & Son, Tower Bridge Road, London, S.E.1.

BANKS.
Barclays Bank, Limited.

CANVAS GOODS.
The N.F. Waterproofing Co., Ltd., Woodside Lane, N. Finchley, N.12.

CHINA CLAY AND CHINA STONE.
Best, Jas., & Sons, Longport, Stoke-on-Trent.
Bloomdale China Clay Co., Ltd., 80, Bishopsgate, E.C.
Burthy China Clay Co., Y.M.C.A. Buildings, St. Austell.
Carbis China Clay & Brick Co., Y.M.C.A. Buildings, St. Austell.
Catalpo, Ltd., London.
Dartmoor China Clay Co., Ltd., 11, Queen Victoria St., E.C.4.
Dyer, Samuel J., Market Hill, St. Austell.
English China Clays, Ltd., St. Austell.
Fox, Roy & Co., Plymouth.
Grose & Stocker, Stoke-on-Trent.
Lovering, J., & Co., St. Austell.
New Consolidated Mines of Cornwall, Ltd., St. Austell and London.
New Halwyn China Clay Co., Y.M.C.A. Buildings, St. Austell.
Newquay China Clay Co., Ltd., Newquay, Cornwall.
North Goonbarrow China Clay, Ltd., 3, Victoria Place, St. Austell.
Parkyn & Peters.
Pochin, H. D., & Co., Manchester.
Somerset Oxide and Ochre Co.
Tehidy Minerals, Ltd., 3, St. Petroc House, Bodmin, Cornwall.
Trethowal China Clay Co., Y.M.C.A. Buildings, St. Austell.
United China Clay Co., Ltd., 80, Bishopsgate, E.C.2.
Varcoes China Clays, Ltd., 107, Market Street, Manchester.
West Carclaze China Clay Co., St. Austell.
Wood, T.A.V., Ltd., Grant's Walk, St. Austell.

COALS.
Cornish Mines Supplies Co., Ltd., St. Austell.
Dunkerton Collieries, Dunkerton, near Bath.
H. Rees Jones & Co., Cardiff.
Stockwood, Rees & Co., Ltd.
Welsh Navigation Steam Coal Co., Ltd., Cardiff.

COLLIERIES.
Dunkerton Collieries, Ltd., Dunkerton, near Bath.
Rees Jones & Co., Ltd., Cardiff.

COLOURS AND CHEMICALS.
Brown, R. B., & Co., 45, Finsbury Square, E.C.
Podmore, W. & A. J., Caledonian Mills, Shelton, Stoke-on-Trent.

ELECTRICAL ENGINEERS.
Harry H. Gardam & Co., Ltd., Staines.

ENGINEERS.
Holman Bros., Camborne.
Paulls (Engineers), Ltd., Fowey.
Sidney Smith & Blyth, Ltd., Garratt Lane, Wandsworth, S.W.18.

FILTERPRESS.
Premier Filterpress Co., Finsbury Pavement House, E.C.

GAS ENGINES.
Crossley Bros., Ltd., Manchester.

IRONMONGERS.
Cornish Mines Supplies Co., Ltd., St. Austell.
Stocker, F. E., Ltd., St. Austell.
Hawke & Son, St. Austell.

LAND & MINE SURVEYORS.
Trythall & Champion, Camborne.

LUBRICANTS.
Cornish Mines Supply Co., Ltd., St. Austell.
Reliance Lubricating Oil Co., Ltd., 19–20, Water Lane, E.C.
Willcox, W. H., & Co., Ltd., 32–38, Southwark Street, London, S.E.1.

MINING ENGINEERS.
Rich, Wm., & Sons, Redruth.

MINING MACHINERY.
Alluvials Mining Machinery Co., 2, Broad Street Place, E.C.
Cornish Mines Supplies Co., Ltd., St. Austell.
Hadfields, Ltd., East Hecla Works, Tinsley, Sheffield.
Rich, Wm., & Sons, Redruth, Cornwall.

MINING SUPPLIES.
Cornish Mines Supply Co., Ltd., St. Austell.
Hadfields, Ltd., East Hecla Works, Tinsley, Sheffield.
Holman Bros., Camborne.
Rich, Wm., & Sons, Redruth, Cornwall.

MOTOR TRANSPORT.
Mid-Cornwall Transport Co., Ltd. (1922), Bodmin Road, St. Austell.

PIPES.
British Mannesmann Tube Co., Ltd., Salisbury House, London Wall, E.C.2.
Ryland, A., Cradley Heath, Staffs.

PUMPS.
Alluvials Mining Machinery Co., 2, Broad Street Place, E.C.
Cornish Mines Supplies Co., Ltd., St. Austell.
Willcox, W. H., & Co., Ltd., 32–38, Southwark Street, London, S.E.1.

QUARRYING AND MINING REQUISITES.
Cornish Mines Supplies Co., Ltd., St. Austell.
Hadfields, Ltd., East Hecla Works, Tinsley, Sheffield.
Rich, Wm., & Sons, Redruth, Cornwall.
Warden, F. H., Ltd., Birmingham.

RAILS (Bridge, Flange, Double or Bullhead).
Bute Works Supply Co., Ltd., 53, Cymric Buildings, Cardiff.

RAILWAY WAGONS.
Bute Works Supply Co., Ltd., 53, Cymric Buildings, Cardiff.
Roberts, Charles, & Co., Ltd., Horbury Junction, nr. Wakefield.

ROPES.
Cornish Mines Supplies Co., Ltd., St. Austell.

SHIPBROKERS.
Blake, G. A., 11, High Cross Street, St. Austell.
Ludlow & Sons, Penzance.
Simpson, Spence & Young, London.
Toyne, Carter & Co., Fowey.

SACKS & BAGS.
Andrew Weir & Co., 21, Parliament Street, Liverpool.
Boag, Thos., & Co., Ltd., Greenock.
Cornish Mines Supplies Co., Ltd., St. Austell.
Dovener, J. H., & Co., Union Street, Liverpool.
North Mills Co., Ltd., Little Peter Street, Manchester.
The N.F. Waterproofing Co., Ltd., Woodside Lane, N. Finchley, N.12.

TIMBER IMPORTERS.
Cornish Mines Supplies Co., Ltd., St. Austell.
Fox, Eliott & Co., Plymouth.
T. Warne, St. Austell.

WATERPROOFING.
The N.F. Waterproofing Co., Ltd., Woodside Lane, N. Finchley, N.12.

WIRE ROPES.
Hood Haggie & Son, Ltd., Newcastle-on-Tyne.
Stephens, John, & Son, Ltd., Falmouth, England.

The China Clay Trade Review

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Mechanical Methods in Clay Works

WITH the present increase of unemployment in the China Clay industry, the question is naturally raised as to why the industry is unable to absorb the unskilled labour of the Cornwall and Devon rural areas in which the China Clay pits are situated. As in other industries, so in China Clay there are cycles of trade depression when the numbers of unemployed are greater than usual. At the present time, undoubtedly, the employment market has been affected by the temporary reduction in demand compared with last year, but though this is so it must be recognised that the China Clay districts are faced with a permanent number of unemployed in consequence of the lessened demand for unskilled labour through the introduction of various classes of mechanical power which now do the work that used to be done by manual labour.

More Machinery

THERE was a time, and that only a few years ago, when it used to be a reproach against the China Clay producers that they relied too much upon manual labour in the production of China Clay and too little upon machinery. That was in the days when the normal pay of the clay workers was round about £1 1s. a week, but since that time, and especially since 1914, when at one period wages rose to three times that amount, there has been a big increase in the use of machinery and mechanical devices for the lessening of production costs.

The China Clay industry has undergone several distinct phases in the course of its history, and to-day it may be said to have reached the machinery stage of its development, for never before in its history has it been so willing to adopt machinery as it is to-day. The reason for this is not far to seek. As elsewhere, so in the China Clay industry it has been found that when manual labour costs reach a certain figure it is more economical to introduce machinery to do the work formerly done by manual labour.

Types of Machinery

THE general adoption of hydraulic hose working under pressure for the washing of the clay in the pits is a conspicuous example of this. Before the war, most of the clay works still clung to the hand-breaking and washing of clay, but this is now the exception. It is only in recent years that China Clay producers have realised the value of suction gas plants and electrical machinery for pumping and power purposes, while those who still prefer steam are installing the latest steam engines, in the development of which use in the China Clay works there has been quite a big advance among makers of this class of machinery.

The practice, which is now very generally followed, of piping the clay to dries alongside railways and docks has created a great demand for steel pipes, which have superceded the old earthenware pipe owing to more expeditious laying and greater durability.

Ropeway Transporters

A CLASS of machinery as yet in its infancy as regards its use in the China Clay works is the mechanical conveyor and the ropeway for the transport of material from one point to another. Such works as have introduced them have found them an advantage, and as their use becomes known there is no reason why their adoption should not become fairly general.

As with machinery more connected with the production of China Clay and the uncovering of overburden and its removal by mechanical contrivances, so in the case of up-to-date rolling stock the clay works are alive to its advantage from the point of view of speed and economy. In this connection reference must be made to the travelling platforms and cranes used in the clay dries and engine houses, and to tram waggons, winding machinery and light engines for hauling purposes in the works.

Further, the use of motor lorries for the quick delivery of China Clay from the works to the stations and ports, where the works are not connected up by pipe lines with these points of despatch, is greatly on the increase.

The Evolution to Modern Methods

THESE are a few instances that come to one's mind as showing the modern attitude of China Clay producers towards the wider use of machinery in every branch of their industry. Suppliers of machinery have only to convince the China Clay producers of the advantage of its uses to gain its ready acceptance.

In considering this question of the increased use of machinery, it is interesting to cite the views of an old China Clay producer on the evolution of the machinery phase in China Clay working. This producer referred in detail to the work in connection with winning the clay, and pointed out that whereas in the past, for breaking the clay, a dubber, doubtless developed from the ancient miner's pick, was used, water pressure was now being largely utilised. About 35 years ago the West of England Co. tried the experiment with a steam fire engine, but they were not satisfied with the result. The experiment did not appear to have been repeated until the last fifteen years, since when hydraulising by jets of water under gravity pressure in the deeper works and by pressure pumps in the shallow ones has been successfully applied and has become very general.

An elaborate mechanical contrivance has been installed by a China Clay company for the separation of the clay from the sand and mica in order to dispense with the great lengths of settling channels. The whole of the works have been laid out so as to substitute mechanical appliances, where possible, for manual labour.

Steam Power

IT is difficult to ascertain when steam power was first applied to China Clay working for the purpose of pumping, but probably one of the first places was North Goonbarrow. The above authority stated that general application of steam power followed the lines of the usual mining practice of the county with the Cornish engine, either the direct action or the rotary having preference. In the case of smaller engines, the horizontal type appeared to receive a marked preference over the vertical. When all the circumstances were taken into account, it was very doubtful if the direct-acting Cornish engine had any equal for mining, and one frequently heard of very wonderful examples of durability, reliability and economy.

Basic Industrial Minerals: No. II.—Barytes

By G. Malcolm Dyson, Ph.D., A.I.C.

In this article, Dr. Dyson continues the series which he commenced last month with one dealing with mica. It is hoped to publish further contributions from time to time.

ALTHOUGH it was Scheele in 1774 who first recognised the fact that barytes was the salt of a hitherto undiscovered element, the mineral had been in use for a century previously. A shoemaker of Bologna, V. Casciorolus by name, had observed that if this mineral was heated for a long period with carbonaceous matter a substance was obtained which glowed in the dark after the manner of phosphorus. He called his new preparation "lapis solis," but the name "Bolognian (or Bononian) Phosphorus" is that by which it has been almost universally described.

The mineral barytes, which is now known to be barium sulphate, must have been something of a puzzle to earlier investigators on account of its refractory and chemically inert nature. Thus, in 1760, a highly skilled mineralogical analyst, Justi, remarked: "Our analysis has here reached its limits; we know of no smelting operation by which anything can be got out of this spar. Many profound chemists and skilful assayers have here tried their art in vain." Scheele settled the problem fourteen years later during his investigation of the black oxide of manganese, and showed barytes to be the sulphate of a new earth, which was later named "baryta." The name comes from the Greek word meaning heavy.

Distribution

The mineral, often known as "heavy spar," is the main source of barium found in nature. It is fairly widely distributed, and often occurs as a "filling" in the lodes associated with copper ores. The carbonate of barium is much less common, and much commercial barium carbonate is obtained chemically from the sulphate. It is of interest from the mineralogical standpoint to note that a complex form of barytes is known in which the barium is partly replaced by strontium and calcium. It is known as barytocelestine, $(BaSrCa)SO_4$.

Barytes is mined in many places in this country, to the total extent of 20,000 tons annually, much of which is brought up at Minsterley, Salop; even so this quantity does not satisfy the demand, some 40,000 tons being imported annually. The graph below indicates the imports during the past few years. Occasionally it is found in clear transparent crystals, but the more usual forms are the pink and bluish-gray white crystalline masses which form commercial barytes. The colour is due to traces of impurities, mainly iron, manganese and copper, present in the form of haematite or pyrites.

GRAPH SHEWING IMPORTS OF BARYTES

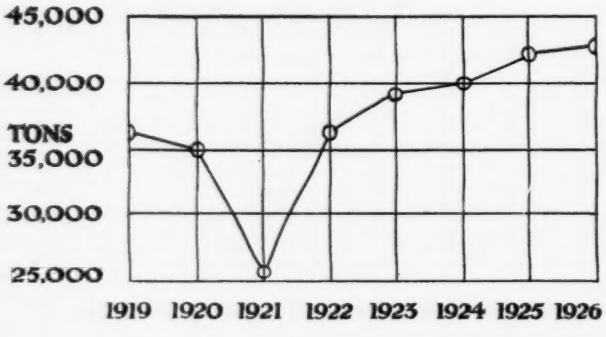

FIG. 1.

The mineral must be subjected to a fairly complicated set of operations before it is of use as a pigment or filler, in which capacities it is chiefly used. Preliminary breaking down is done by the Ajax type of crusher, followed by trommel sorting, in which pieces larger than ¾ in. are returned to the raw material dump. The next process involves mechanically grading into sizes, after which the various sizes are again sorted into various qualities by means of hydraulic jigs. The rest of the treatment comprises bleaching and pulverising. The bleaching is a comparatively simple operation, in which the better qualities of barytes are treated with a sulphuric acid solution of 10–15 per cent. strength, a process which removes the copper and iron, leaving the material quite white. After washing and drying, the material is pulverised in the disintegrating type of mill. The final grinding of barytes is the most important operation, since on the fineness of grinding depends the quality and value of the finished material, and samples of the ground material are examined every few minutes during the grinding of a batch in order to ascertain the degree of fineness. It goes almost without saying that the final classification is performed by means of air flotation.

The Properties of Barytes

Barium sulphate crystallises in the rhombic system, and although it is at times found in the simple form shown in the left-hand figure below, the more usual shape of the mineral crystals is that given in the right-hand figure. When ground to a particle size of 5–10μ, the crystals still show their crystal-

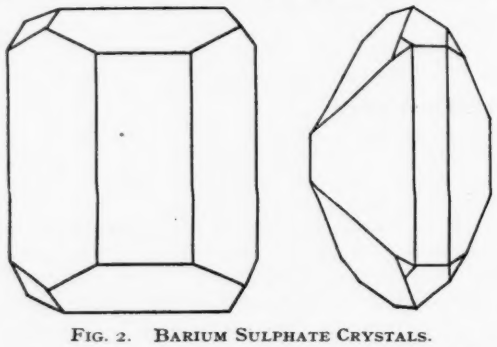

FIG. 2. BARIUM SULPHATE CRYSTALS.

line nature on microscopic examination, the angles and cleavage marks being quite plain. The refractive index is about 1·64, and particles of the ground barytes are almost invisible when suspended in α-bromnaphthalene. The natural substance has a density of 4·48, but the precipitated sulphate has a density of 4·53.

The density and refractive index, together with the fact that large quantities are available cheaply, make the substance useful as a pigment, but the success of the material in this direction is entirely a matter of grinding, and the rougher empirical tests for fineness in this direction have been replaced by more scientific methods. The older tests, such as biting the sample, or rubbing it between two pieces of plate glass, have been ousted by microscopical examination. An image of the particles is projected through a microscope fitted with standard lenses on to a screen marked into squares. In this way it can be immediately seen whether the particles correspond to the requirements of fineness. This development is due to Colonel Ramsden, of the Malehurst Barytes Co., Ltd., as is also an improved microphotometer for estimating the whiteness of barytes samples, which are compared optically with a standard preparation of magnesia. Barytes of good pigment quality should not alter much in colour when moistened with a little turpentine; barytes which does alter in colour in this way, assuming a grey shade, is of little value except for low-grade work.

Uses of Barytes

There are several ways in which barium sulphate can be used in the pigment industry. In itself it is a mineral pigment of considerable value, although it does not approach white lead in covering power; it has, however, the inestimable advantage of being almost unaffected by chemical vapours of any type, and still appears to be holding its own against titanium dioxide, its only serious rival in the manufacture of white paints. Its admixture with other pigments accounts

for much of the ground barytes used industrially. When mixed with greens and chromes it improves the "laying" qualities and brightens the colours considerably, without having any detrimental effect on the paint. The lower classes of barytes are, of course, used for the darker shades, but very inferior barytes is not recommended, since the amount of oil that must be used increases with the decrease in quality of the barytes. The preparation of "permanent white" and "blanc fixe" is not usually carried out with the ground natural barytes, since very much better results are obtained with the precipitated variety. Much of the barium sulphate of commerce is converted to lithopone. The first stage in the preparation of the lithopone is the conversion of the barium sulphate into sulphide :—

$$BaSO_4 + 4C = BaS + 4CO$$

by the simple process of roasting with charcoal until reduction is complete. The barium sulphide is extracted with water and the solution added to one of zinc sulphate. A precipitate containing both barium sulphate and zinc sulphide is obtained, which after washing and heat treatment forms the lithopone of commerce. The zinc sulphate may be replaced by cadmium sulphate, which gives a cadmium lithopone of great value in the manufacture of certain printing inks.

In the paper trade, barytes is used as a loading material, giving a brilliant white finish with coated papers, whilst with aluminium hydroxide it is used as "Satin White" for finishing art papers. The use of barytes in this way is considered inadvisable in some circles owing to the ease with which it settles out at the beaters. Other uses for barytes, which account for only a small fraction of the output, comprise its use as a mineral filler mainly in the rubber industry, in oil refining for purposes of purification, and for the production of certain types of opaque glazes in the ceramic industries.

Developing the China Clay Industry

A Review of the Situation

In the "St. Austell Gazette" for November 8, a correspondent ("S. P. B.") makes some interesting remarks on the position and development of the China Clay industry.

A HIGH average of unemployment in a district (states the *St. Austell Gazette* writer) is a constant drag upon business development, because of the limitations of the spending power of large numbers of the community. In the St. Austell district a high or low percentage of employment is dependent upon the China Clay industry. It is well known, in the China Clay trade at any rate, that the capacity of the plants now working is such that they are capable of turning out at least double the quantity of China Clay now sold. The price at which China Clay is now being sold allows only a fair margin of profit to the producers and permits of nothing more than a reasonable living wage to the China Clay workers. So the cutting of prices to secure a bigger turnover would be no advantage financially, because in the process neither the producers nor the clay workers would be better off.

Cultivating a Bigger Demand

The development of a bigger turnover, to permit of a fair return on the capital employed and to assure a reasonable living wage to those employed in the industry, lies in the cultivation of a bigger demand. Here it is that publicity would greatly help, but such a means for developing trade the China Clay industry as a whole has never favoured. Yet there is enormous scope for letting the world know that Cornwall and Devon produce the finest and most versatile raw material, and, for what it does, the most inexpensive.

A correspondent in one of the trade papers recently asked the question : "Couldn't the China Clay producers find more uses for China Clay ?" The answer is : "Yes, if they take the steps which other great businesses take to extend markets." The same correspondent went on to refer to the great fillip the discovery of the suitability of China Clay as a filler in paper, rubber, paint and linoleum gave to the volume of business when it came to be used as a raw material in these manufactures. This correspondent adds : "If one further use could be found such as paper making, where about 400,000 tons are used annually, China Clay producers could be working full-speed ahead."

I believe there are extended uses to which China Clay could be put if the industry undertook systematic research and publicity. For such highly refined purposes as toilet powders, the demand is growing as their use by the fair sex grows. Judging by the prices charged for powdered China Clay dyed to a suitable shade, the raw material sold for such purposes commands a high price. Though there is scope here for more business, the quantity required is not such as to have any great effect on the volume of China Clay production.

In the gramophone records industry there may be scope for bigger things, as I understand that in the composition of some records best China Clay enters. Purposes for which cheaper China Clays are being increasingly used are for the making of cheap statuary and images of various kinds, for which there appears to be a growing vogue, and in the figures used as dummies for showing off fashions, which are taking the place of the old-fashioned wooden dummies and wax faces formerly used in the drapers and tailors' shops.

Need for Publicity

It is in giving publicity to the adaptability of China Clay for these and a variety of other new purposes, which inquiry and research will reveal, that an increased demand for China Clay could be cultivated so that plants could be employed to greater extent in increasing the turnover of producers.

Another aspect of trade development locally has to do with the facilities the district offers for industry. The drawback of the south-west in years gone by has been its remoteness from the coalfields, but now that electricity is being increasingly used this handicap no longer applies. Are we in the West sufficiently alive to the tendency that is growing for industrial concerns to move from the Midlands to the South and West by bringing to the notice of the leaders of industry the facilities this district offers for the establishment of factories ? On the sea board, with three useful little ports—Par, Charlestown, and Pentewan—and with electric power available, we can offer industry ideal sites for factories and producer plants without encroaching upon the beauty spots of the locality. Compared with the big over-crowded industrial centres we can offer cheaper sites and lower rents and rates.

Revival of Chamber of Trade Suggested

The question arises as to who should be responsible for keeping St. Austell's business end up. In some towns, the municipal authority makes it a part of its business to use every possible channel for cultivating trade, realising that this brings rateable value. I notice that Newport (Mon.) has just appointed an official as town organiser whose duties will be to foster the town's business, put down extravagance and introduce economies where warranted. St. Austell is not big enough to justify a separate official, but his functions could be very usefully undertaken by a live Chamber of Trade. Mainly through lack of a proper co-operative spirit, the St. Austell Chamber of Trade, which started off with so much promise, was allowed to lapse. Its revival is essential if St. Austell is to speak with authority on business matters and if anything practical is to be done in attracting more trade in the directions I have indicated. "Anybody's business is nobody's business," is an old saying which holds good in this matter of what may be called community publicity. A Chamber of Trade is the most suitable organisation for the work, it being unhampered by the restrictions that govern local bodies and being able to make representations on behalf of the business community regardless of municipal boundaries. St. Austell is in danger of standing still and resting on its laurels while other towns are developing commercially as well as municipally. Publicity on the part of the business community—individually as well as co-operatively—is the chief medium by which St. Austell can expect to maintain a place in the sun.

China Clay Notes and News

Unemployment Position and Clay Demand

THE drop in volume of China Clay business this year compared with last has, naturally, temporarily influenced the unemployment position, there being registered as unemployed in mid-Cornwall something like 800 persons. A large proportion of this number would be represented by those normally employed in the China Clay industry. In this connection the letter addressed by the National Federation of Clay Industries to the Prime Minister is interesting :—

"The members of this Federation, in common with other employers of labour, have received your personal appeal to help to relieve the severe unemployment in the depressed areas by offering employment to as many men and boys as possible from those areas.

"While our members are keenly anxious to support your appeal to the fullest possible extent, their opportunities for doing so are greatly restricted by the prevailing depression in many sections of the clay industries. This depression is being greatly aggravated, particularly in the South Eastern and coastal areas, by the large importations of foreign-made bricks, tiles, etc. Were it not for this importation, a considerably increased number of British workmen could be found employment in the clay industries.

"Further, in view of the important part which coal plays in the burning of clay goods, the coal industry itself would considerably benefit, and favourable reaction would fall on other British industries. Notwithstanding the great falling off in building operations during 1928, no fewer than 179,944,000 building bricks and 38,185,962 roofing tiles were imported into this country in the eight months ended August 31.

"The Federation has carefully considered the seriousness of the importations in the light of your appeal, and urges upon his Majesty's Government the utmost need for action in the direction of reducing the importation of foreign clay-building materials, particularly by placing an embargo on the use of such materials in housing and other public schemes carried out in areas where abundant British materials are available, and which receive financial aid from public funds. Government action on the lines indicated would be a practical way of stimulating British industry, and would make possible the employment of additional British workmen."

China Clay Workers' Railway Bungalows.

THERE has recently been some discussion in the St. Austell Rural Council with reference to the growing habit of China Clay workers of acquiring disused railway carriages for use as bungalows. Some members have been objecting to these as blots on the landscape, and have moved to prohibit their extended use, but the Council has decided to permit them in suitable cases where they are not likely to cause a nuisance or to deteriorate the value of adjoining properties. These bungalows, which can be erected on the spot and made fit for occupation at an inclusive cost of under £50, are said to be capable of providing adequate accommodation for a family of five persons, and permit plenty of ventilation, being 7 ft. high. They are helping to solve the housing question for the lower-paid China Clay workers and others.

China Clay Works Fatality

A SINGULAR fatality was inquired into by the Coroner last month, when an inquest was held on Percy Hocking Smale, aged 32, who was killed while working in H. D. Pochin and Co.'s China Clay quarry, at South Caudle Down, near St. Austell.

William Henry Moses, who was working with deceased in the pit, said he was engaged in washing clay from the face of the pit with a hose. He was standing on the level right at the bottom. Deceased was about 20 ft. from the face of the pit. Witness was about 20 yds. from him. He heard two or three pebbles fall from somewhere on the top, and looked up but saw nothing else. He shouted to Smale. Then he saw a big rock in the air. It came straight down, struck a ledge, and then dropped towards Smale, striking him on the back of the head and knocking him down. Witness went to him at once. Witness said that he had no more idea than the man in the moon where the stone came from. The one that struck deceased weighed about half-a-hundredweight.

Thomas Harry Tabb, captain of the clay quarry, said he could not find the spot from which the rock fell. He inspected the quarry personally every day to find out whether it was safe to work in. The pit was about 300 ft. deep. He could not give any idea of how this rock fell, other than the bad weather.

In reply to Mr. R. King, Inspector of Mines and Quarries, Captain Tabb said he was continually inspecting the pit during the day. One part of the pit, just where the deceased stood, was practically vertical; then it battered out considerably. The stone must have come from the side of the quarry where the batter was above the vertical part. The dry summer weather might have caused cracks which the water might have got into, and then one did not know quite what was going to happen.

The medical evidence showed that the deceased's head was crushed and that death was instantaneous. A verdict of accidental death was recorded.

Clay Exports of All Types

THE Board of Trade returns for the month of October give the usual details with regard to clay exports. China Clay (including Cornish or China Stone) was exported to the extent of 61,367 tons (as compared with 58,015 in October, 1927), valued at £135,967 (as compared with £115,328); while for the 10 months ending October 31, exports amounted to 497,750 tons (as compared with 539,369 in 1927), valued at £1,099,446 (as compared with £1,125,592). Exports of fireclay in October amounted to 3,901 tons (as compared with 2,875 tons), valued at £5,790 (as compared with £4,224), and in the ten months ending October 31 to 28,753 tons (as compared with 23,286 tons), valued at £51,197 (as compared with £45,772). Exports of other sorts of clay in October were 8,326 tons (as compared with 6,765 tons), valued at £17,717 (as compared with £13,679), and for the ten months ending October 31, 73,102 tons (as compared with 74,944 tons), valued at £155,802 (as compared with £163,494). The total value of all types of clay exported in October was £159,734 (as compared with £133,251 in October, 1927), and in the ten months ending October 31, £1,306,445 (as compared with £1,334,858).

U.S. Sand and Gravel Deposits

THE sand and gravel industry has developed phenomenally in the past few years, according to the United States Bureau of Mines, Department of Commerce. From 1922 to 1927, the volume of production of sand and gravel in the United States increased more than 100 per cent. A probable result of such rapid expansion in any industry is the promotion of new projects without adequate study of economic conditions. The ease with which new sand and gravel operations may be started greatly facilitates this expansion. The failure of a new enterprise means bankruptcy to the individual company, and efforts to maintain production in the face of adverse conditions usually have a demoralising effect on the industry as a whole. The United States Bureau of Mines, through the building materials section of the rare metals and non-metals division, has undertaken the task of outlining the conditions that require study prior to starting a new operation. It is hoped that the forthcoming report will encourage prospective operators to give due study to the factors on which success depends, and thus forestall the beginning of enterprises that would probably result in failure.

The Indian Pottery Industry

IN a lecture on the pottery industry in India, delivered before the Bengal National Chamber of Commerce at Calcutta, Mr. S. Deb stated that an attempt is being made to utilise the resources of raw material in Bihar by starting an up-to-date pottery works on modern lines at Mihijam in the Santal Parganas. A company under the name of Bihar Pottery Works, Ltd., has duly been registered at Patna with a capital of Rs. 5 lakhs, to give effect to this scheme. The company intends to manufacture high and low tension insulators, table china, and sanitary ware. There are said to be deposits in Bihar and Orissa of mineral resources for the manufacture of glazed pottery, which is quite a new line in India. At present, the imports of glazed pottery into India amount annually in value to about Rs. 75 lakhs.

Shipping and Export News of the Month

We give herewith latest particulars relating to arrivals and sailings of ships engaged in the China Clay trade, at the principal British clay ports. Registered exports of China Clay, with countries of destination, and other shipping and export matters are dealt with.

Fowey Shipping—October, 1928

Arrived.	Name.	Sailed.	Destination.
October 1,	M.V. *Shamrock*	October 2,	Plymouth
October 1,	M.V. *Lyhner*	October 2,	Plymouth
October 2,	S.S. *Cornish Trader*	October 5,	Newlyn
October 2,	S.S. *Guelder Rose*	October 8,	Runcorn
October 3,	S.S. *Lister*	October 6,	Kotka
October 3,	S.V. *Sarah Evans*	October 9,	Looe
October 3,	M.V. *Roselyne*	October 6,	Terneuzen
October 4,	S.S. *Farfield*	October 5,	Grimsby
October 4,	S.S. *Fullerton Rose*	October 6,	Brussels
October 5,	S.S. *Horsham*	October 9,	Antwerp
October 5,	S.S. *Hayle*	October 9,	Fleetwood
October 5,	S.S. *Gouwestroom*	October 9,	Amsterdam
October 6,	S.S. *Dorrien Rose*	October 9,	Antwerp
October 6,	S.S. *Inna*	October 10,	Drammen
October 6,	S.S. *Weston*	October 10,	Liverpool
October 6,	S.V. *Flora*	October 12,	Gefle
October 7,	M.V. *Drogden*	October 12,	Gothenburg
October 7,	S.S. *Greta*	October 11,	Oscarshamm
October 7,	S.S. *Eskbridge*	October 13,	Portland Me.
October 8,	S.S. *Mersey*	October 12,	Ridham
October 10,	S.S. *Horn*	October 13,	Antwerp
October 10,	S.S. *Agnes*	October 13,	Halden
October 10,	S.S. *Brier Rose*	October 13,	Runcorn
October 10,	S.S. *Blush Rose*	October 16,	Weston Point
October 11,	S.S. *Cisneros*	October 13,	Barcelona
October 11,	M.V. *Diligent*	October 12,	Mevagissey
October 11,	S.S. *Whinhill*	October 13,	Rouen
October 13,	S.S. *Ida*	October 17,	Antwerp
October 13,	S.S. *Sturdee Rose*	October 16,	Preston
October 13,	S.S. *Verna*	October 17,	Hamburg
October 13,	S.S. *Geraldine Mary*	October 17,	Botwood Nfld.
October 13,	S.S. *Sture*	October 17,	Helsingborg
October 14,	M.V. *Dietrich Hasseldiech*	October 16,	Hamburg
October 15,	S.S. *Tynebridge*	October 20,	Portland Me.
October 15,	M.V. *Atlanta*	October 18,	Harburg
October 16,	S.S. *Farfield*	October 19,	Antwerp
October 17,	S.S. *Sarnia*	October 19,	Pasages and Bilbao
October 17,	S.V. *Catherine*	October 25,	Stettin
October 17,	S.S. *New York City*	October 24,	Biston
October 17,	S.S. *Brynawel*	October 17,	Porthoustock
October 18,	S.S. *Austin Gough*	October 20,	Hamburg
October 19,	S.S. *Rivelin*	October 22,	Antwerp
October 20,	S.S. *Hayle*	October 24,	Larne
October 20,	S.S. *Susetta*	October 25,	Weston Point
October 22,	S.S. *Lieut. le Mounier*	October 24,	Rouen
October 22,	S.S. *Fulton*	October 24,	Skien
October 22,	M.V. *A. H. Both*	October 25,	Reval
October 22,	S.S. *Holtby*	October 28,	Philadelphia
October 23,	S.S. *Snofrid*	October 25,	Sarpsborg
October 23,	S.S. *Stanwell*	October 26,	Aberdeen
October 25,	S.S. *Weston*	October 27,	Liverpool
October 25,	S.S. *Horn*	October 30,	Pasages
October 25,	S.S. *Pansy*	October 29,	Ridham
October 25,	S.S. *Mersey*	October 26,	Ridham
October 25,	S.S. *Brier Rose*	October 30,	Weston Point
October 26,	S.S. *Vliestroom*	October 29,	Amsterdam
October 27,	S.S. *Millpool*	November 3,	Portland Me.
October 27,	S.S. *Yrsa*	November 1,	Genoa
October 28,	S.S. *Gouwestroom*	November 2,	Amsterdam
October 28,	S.S. *Beston*	November 2,	Liverpool
October 29,	S.S. *Scheldejol*	November 2,	Terneuzen
October 29,	S.S. *Porthcarrack*	November 2,	Hamburg
October 29,	S.V. *Glory*	*	Halden
October 31,	S.S. *Foch Rose*	November 3,	Rouen
October 31,	S.S. *Wild Rose*	November 3,	Bo'ness
October 31,	S.S. *Pentor*	*	Philadelphia
October 31,	S.S. *Wyke Regis*	November 3,	Ghent

* Signifies "In Port."

Par Harbour Shipping—October, 1928

Arrivals

Date.	Vessel.	From
October 1,	S.S. *Marena*	Falmouth
October 2,	S.V. *Lady Agnes*	Looe
October 3,	M.V. *Isabel*	Falmouth
October 3,	S.V. *Oceanic*	Falmouth
October 4,	S.S. *Glenrose*	Dartmouth
October 4,	S.S. *Treleigh*	Portreath
October 6,	S.V. *Emma Esther*	Falmouth
October 7,	S.S. *Goole*	Plymouth
October 8,	S.V. *Mary Miller*	Falmouth
October 9,	S.S. *Magrix*	Middlesbrough
October 10,	S.S. *Robrix*	Penzance
October 10,	S.S. *Sture*	Gothenburg
October 12,	S.S. *Edern*	Port Talbot
October 13,	S.S. *Artificer*	Middlesbrough
October 13,	S.S. *Clyde Firth*	London
October 18,	S.V. *Ravenscraig*	Portleven
October 22,	S.V. *Lucy*	Charlestown
October 27,	S.V. *C. & F. Nurse*	Polperro
October 28,	S.S. *Knowl Grove*	Blyth
October 29,	M.V. *Romanie*	Cardiff
October 30,	S.S. *Jolly Marie*	Truro
October 31,	S.S. *Rayford*	Blyth
October 31,	M.V. *Princessan*	Borga

Sailings

Date.	Vessel.	Destination.
October 1,	S.S. *Marta*	Gothenburg
October 1,	S.V. *Mary Ann*	Weston Point
October 1,	S.S. *Artificer*	Rouen
October 2,	S.S. *Mount Charles*	Lancaster
October 3,	S.S. *Marena*	Terneuzen
October 4,	S.S. *Glenrose*	Gravesend
October 5,	S.S. *Treleigh*	Preston
October 10,	M.V. *Amazon*	Pentewan
October 10,	S.V. *Lady Agnes*	London
October 10,	S.V. *Oceanic*	Rochester
October 10,	S.V. *Emma & Esther*	Weston Point
October 10,	S.S. *Goole*	London
October 11,	S.S. *Magrix*	Hull
October 13,	S.S. *Robrix*	Antwerp
October 13,	S.S. *Sture*	Fowey
October 15,	S.V. *Mary Miller*	London
October 15,	S.S. *Artificer*	Plymouth
October 16,	S.S. *Clyde Firth*	Newlyn
October 16,	S.S. *Edern*	Antwerp
October 19,	S.S. *Ravenscraig*	Antwerp
October 29,	M.V. *Isabel*	Plymouth
October 30,	S.V. *C. & F. Nurse*	Rochester

Charlestown Shipping—October, 1928

Arrived.	Vessel.	From.	Sailed.	Destination.
September 17,	S.V. *Pet*	Runcorn	October 2,	Runcorn
September 24,	S.V. *Lady Jean*	Pentewan	October 6,	Rochester
September 25,	S.S. *Blanche*	Kotka	October 2,	Leith
September 25,	S.V. *Flying Foam*	Glasgow	October 8,	London
September 29,	S.V. *Vera*	Raumo	October 13,	Aberdeen
October 2,	S.V. *Ethel, Edith*	London	October 15,	Goole
October 5,	S.V. *John Simms*	Falmouth	October 10,	Runcorn
October 10,	S.V. *Emily Warbrick*	Falmouth	October 15,	London
October 11,	S.S. *Stanwell*	Cardiff	October 15,	Nantes
October 15,	S.V. *My Lady*	Port Talbot	October 27,	Kirkaldy
October 28,	S.S. *Coaster*	Penryn	October 31,	Dunkirk

October Deliveries

1,600 Tons Above September

THE total aggregate tonnage dealt with in October was only 1,600 tons above September, so the balance compared with last year is improved to that extent. China Clay showed an increase of nearly 5,000 tons, there being a drop of nearly 2,000 tons in China Stone and 1,200 in Ball Clay. Details :—

	China Clay.		China Stone.		Ball Clay.		Total.	
Port.	Tons. 1928.	Tons. 1927.	Tons. 1928.	Tons. 1927.	Tons. 1928	Tons. 1927.	Tons. 1928.	Tons. 1927.
Falmouth .	180	—	—	—	—	—	180	—
Fowey	58,504	65,541	3,430	2,475	1,709	1,019	63,643	69,035
Looe	176	385	—	—	—	—	176	385
Par	4,658	4,932	497	330	—	—	5,155	5,262
Plymouth..	822	715	—	—	—	—	822	715
Penzance ..	—	1,023	—	—	—	—	—	1,023
Charlestown	2,904	4,384	—	—	—	—	2,904	4,384
By rail	3,904	4,533	—	—	—	—	3,904	4,533
October ...	71,148	81,513	3,927	2,805	1,709	1,019	76,784	85,337
Total 9 mts.	592,096	652,538	37,963	44,254	20,572	18,834	650,631	715,626
Total 10 mts.	663,244	734,051	41,890	47,059	22,281	19,853	727,415	800,963

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

Mortgages and Charges

*[NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case, the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.]*

BLETCHLEY BRICK CO., LTD.—Registered October 5, £20,000 debenture, to Westminster Bank Ltd.; general charge. *£30,000. September 20, 1927.

ADDERLEYS, LTD., Longton, china manufacturers.—Registered October 13, £1,900 (not ex.) mortgage to 5th Longton Borough Mutual Benefit Building Society; charged on Daisy Bank Works, Spring Garden Road, Longton. *£6,000. February 17, 1927.

CLEVELAND TILE WORKS, LTD., Stoke-on-Trent.—Registered October 11, £1,500 debentures; general charge. *Nil. January 12, 1928.

COALVILLE BRICK CO., LTD.—Registered October 10, £100 and £250 debentures, part of £5,000; general charge.

REDHILL TILE CO., LTD.—Registered October 29, £650 charge to T. Cotching, solicitor, Horsham; charged on Hunmanby, The Chase, Beddington. *£4,500. March 22, 1928.

RUBIAN ART POTTERY LTD. (late H. K. BARKER AND CO., LTD.), Fenton.—Registered October 23, £600 further charge, to Leek and Moorlands Building Society; charged on Rubian Art Pottery, Park Road, Fenton. *£4,400. June 26, 1928.

Satisfactions

BLETCHLEY BRICK CO., LTD.—Satisfactions registered October 5, all moneys, etc., registered April 21, 1925, £7,000, registered December 4, 1925, and all moneys, etc. registered August 14, 1926.

DORKING BRICK CO., LTD.—Satisfaction registered October 8, £1,000, part of amount registered January 7, 1926.

CAULDON POTTERIES, LTD., Stoke-on-Trent.—Satisfaction registered October 17, £6,000, part of amount registered January 11, 1926.

KINGS NORTON PAPER MILLS, LTD. Satisfaction registered October 19, £2,000, part of amount registered March 18, 1926.

SIDNEY BRICK AND CLAY WORKS, LTD., London, S.W.—Satisfactions registered October 26, £2,000, registered November 17, 1920, and £2,600 registered June 1, 1921.

Bill of Sale

JONES, Albert Edward (the younger), High Cliff, Star and Garter Road, Longton, earthenware manufacturer. Dated October 17, filed October 20. £200.

London Gazette, &c.

Companies Winding Up Voluntarily

FRADDON CHINA CLAY CO., LTD.—At an Extraordinary General Meeting of the shareholders of the above named Company, duly convened, and held at 18, Tariff Street, Manchester, on October 9, 1928, the following Extraordinary Resolution was duly passed:—

"That the Company cannot, by reason of its liabilities, continue its business, and that it is advisable to wind up the same accordingly. That the Company be wound up voluntarily; and that Mr. Herbert Arscott, of 18, Tariff-street, Manchester, Secretary, be and is hereby appointed Liquidator."

MAR HILL BRICK AND TILE CO., LTD.—At an Extraordinary General Meeting of the above named Company, duly convened, and held at 5, Eldon-chambers, in the city of Nottingham, on October 19, 1928, the following Resolution was duly passed; and at a subsequent Extraordinary General Meeting of the Members of the said Company, also duly convened, and held at the same place, on November 6, 1928, the same Resolution was duly confirmed as a Special Resolution, namely:—

"That the Company be wound up voluntarily, and that Leslie Arthur Tomlinson, of Eldon Chambers, in the city of Nottingham, Incorporated Accountant, be and he is hereby appointed Liquidator for the purposes of such winding-up."

China Clay Exports, October, 1928

A RETURN showing the quantities and values of the exports of China Clay, including Cornish or China Stone, the produce of Great Britain and Northern Ireland, from Great Britain and Northern Ireland as registered in the month of October, 1928, is as follows:—

	Quantity. Tons.	Value £
Finland	4,025	7,646
Estonia	503	1,250
Latvia	1,099	1,536
Sweden	3,466	6,383
Norway	958	2,314
Denmark	750	2,084
Poland	21	68
Germany	3,114	7,588
Netherlands	3,089	7,193
Java	6	18
Belgium	8,127	16,471
France	3,274	7,180
Portugal	26	100
Spain	1,283	2,323
Italy	913	2,283
Greece	4	25
China	6	28
Japan	50	310
United States of America	25,103	56,043
Mexico	365	1,201
Chile	100	380
Brazil	2	9
Irish Free State	10	43
Cape of Good Hope	35	70
Natal	1	6
British India, via Bombay	2,483	7,588
via Madras	10	95
via Bengal, Assam, Bihar and Orissa	215	805
Australia	89	686
New Zealand	4	9
Canada	81	625
Newfoundland and Coast of Labrador	2,155	3,607
	61,367	135,967

China Clay Imports, October, 1928

A RETURN showing the quantities and value of China clay, including China Stone, imported into Great Britain and Northern Ireland, as registered in the month of October, 1928, is as follows:—

Countries Whence Consigned.	Quantity. Tons.	Value. £
Germany	14	60
Belgium	260	1,500
Total	274	1,560

Nova Scotia Diatomaceous Earth

THE Canadian Mining and Metallurgical Bulletin publishes in its August issue a paper presented at the recent annual meeting of the Mining Society of Nova Scotia, by Mr. R. W. Burroughs, entitled "Development of Diatomaceous Earth in Nova Scotia." The industry is now undergoing important developments, and persons interested may consult the paper in question on application to the office of the High Commissioner for Canada, the Canadian Building, Trafalgar Square, London, S.W.1.

The China Clay Trade Review

The Official Organ of the China Clay Industry and the only Journal specially devoted to its interests.

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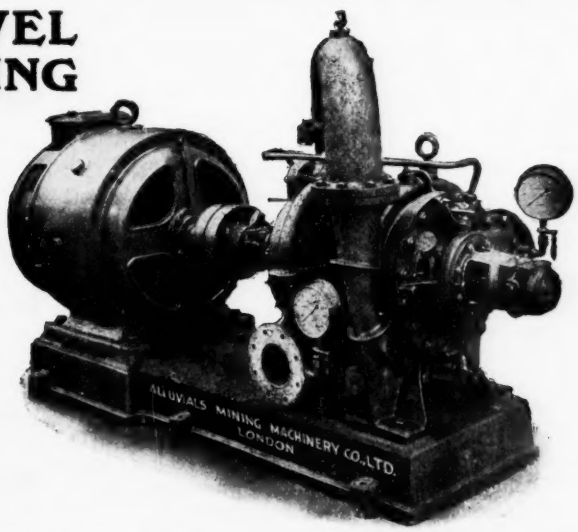

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China Clay Rating Surprise

Not only China Clay producers, but the general body of ratepayers in Cornwall, are much perturbed by the revelation made by Associated China Clays, Ltd., of St. Austell, which represents nearly the whole of the China Clay industry, that the valuation list deposited by the St. Austell Rural District Council contains old figures of valuations not in accordance with the Rating and Valuation Act which comes into operation next April, and which, if not brought up to date, will seriously affect the amount of the de-rating grants under the Government proposals.

China Clay Industry's Attitude

The attitude of the China Clay industry has been explained in letters that have been addressed to the St. Austell Rural District Council, the East Central Assessment Committee, and the Cornwall County Council, in which the position as it affects the ratepayers is explained. The statement of the case which has been issued by the China Clay industry referring to the deposited draft valuation list, says that as regards the hereditaments in the occupation of members of Associated China Clays (the China Clay producers' association) it contains figures of assessment which admittedly have not been arrived at by valuation of the properties to which they refer, as required by the Rating and Valuation Act. The opinion of eminent Counsel, Mr. Konstam, K.C., and Mr. Alfred Hildesley, experts in rating law, have been taken, and they have advised the association that such valuation list has not been made in accordance with the law, and if approved without amendment will be bad. It is furthermore pointed out that if the valuations in the list be inaccurate, and more particularly if they be less than those which will ultimately be fixed as representing the true valuations, the amount of the Exchequer grant to be received by the county and district councils in respect of the loss of rates will not be the right amount, and in the event of it being less than it should be the deficiency will have to be made up by the district and county ratepayers generally, and among them members of the China Clay industry. The importance of the valuations being up to date lies in the fact that the figures approved by April 1 next year are the figures on which the Government rating relief will be payable for five years.

County Council's Aid Invoked

Associated China Clays have also made representations to the County Council as the authority to undertake the administration of the Exchequer contributions arising out of de-rating, submitting that the crisis that has arisen is a matter in which they may properly invoke the assistance of the County Council, who are reminded of the powers that are conferred upon the High Court at the instance of the County Council in regard to defaulting authorities. It is suggested that having regard to the importance of the matter from the point of view of the County, as well as that of the China Clay industry, that the County Council should without delay take the matter up with the St. Austell Rural District Council and the Cornwall East Central Assessment Committee, with a view to such intervention obviating the necessity of the jurisdiction of the High Court being invoked.

It is pointed out on behalf of the industry, that if the present valuation list stands, apart from the question as to whether it can be legally enforced, the position would be that from April next the figures would be the basis on which the Government 75 per cent. relief would be paid for five years, and not on the higher valuations which will become operative when the new valuations are made. To give a concrete example, in the valuation list containing old figures, if the total rates payable amount, say, to £52,000 the amount of the annual relief would be £39,000. On the new and higher valuation list on which the rates payable would be, say, £76,000, the relief at the rate of 75 per cent. on this figure would be £57,000, but if these figures are not included in the list to become operative in April next, the relief for five years on the lower figure would be £39,000, instead of £57,000, so that the difference between the two, namely £18,000, would have to be made up by the general body of ratepayers.

Increased Valuations Likely

In an interview, Mr. T. Medland Stocker, who is the managing director of English China Clays, Ltd. (the largest individual China Clay firm) as well as managing director of Associated China Clays, Ltd. (the producers' association), said that as the result of a conference held between the Rural Rating Authority and the Association several months ago, the system of assessment agreed upon must "in my opinion be a considerable increase in the rateable value of China Clay works, and I fully expected and understood that the valuation list now deposited by the St. Austell Rural Rating Authority would contain valuations made in accordance with the agreed system."

Our Comments

In an area with so many China Clay works possessing varying characteristics and values, the work of valuation has been less easy than in some other parts of the County. It was on that account that the date for the bringing into operation of the new valuations was extended from April this year to April next. But the district and the China Clay industry particularly naturally concluded that the figures in the new list were the results of the special valuations to make which a highly paid expert valuer was appointed. It has been suggested that the reason why the new valuations are not included in the list deposited is that the list is not complete. We understand that the China Clay industries valuer has had his figures ready for some time.

As disclosed in the statement of the position given above, the effect on the finances of the district and County will be extremely serious if a big effort is not made between now and January to complete the valuations so that they can be included in the new list. It is not suggested that the Rural Council has wilfully placed the district in the present dilemma. Possibly the fact that the lists which have to be completed by January are the ones on which the Government de-rating grants will be paid for five years had been overlooked by those concerned.

We understand that the St. Austell Rural Rating Authority are considering the case, following upon the disclosure of the correspondence at the last meeting of the St. Austell Rural Council in committee.

Clay in Pottery

From a Clay Merchant's Standpoint

At a recent meeting of St. Austell Rotary Club, Mr. F. S. Liddicoat, the European representative of the Papermakers' Importing Co. of America, gave an interesting paper on the manufacture of pottery in its relation to China Clay and other clays as raw materials.

THE manufacture of pottery, said Mr. Liddicoat, covered such a wide range, from the making of bricks to the finest qualities of porcelain, that it was only possible to deal with the subject in a general sense. He therefore proposed to deal with the methods employed in the manufacture of ordinary earthenware.

William Cookworthy, having discovered the necessary raw materials in various parts of Cornwall and Devon, established a pottery at Plymouth about 1750 and took out a patent for the manufacture of porcelain from what he termed a "hard paste." We could therefore assume for our purpose that the manufacture of pottery in which Cornwall and Devon became directly connected dated from that time and had since resulted in the building up of our China Clay and Ball Clay industries.

Earthenware Bodies

The "body" was generally composed of China Clay, Ball Clay, China Stone and flint, varying in proportions according to the special formula of the potter, which was more or less secretive and handed down from generation to generation. The China Clay, as now prepared, did not of course require much further treatment, but the Ball Clay was put into a blunger and reduced to a state in which it could be passed through sieves of various sizes in order to free it from lignite and other foreign matter, and to render it of a fine uniform consistency.

The flints, which were usually imported from Dieppe, were first calcined or burnt in a kiln to render them easily broken. They were then crushed, and being afterwards mixed with water, were reduced to the consistency of cream by grinding in circular pans the bottoms of which were commonly paved with hard stone over which heavy stones of a similar nature called "runners," were driven round by machinery, and the crushed flint was thus finely ground in water between them. The China Stone required to be crushed and reduced to a fine powder in grinding mills, the treatment being practically similar to that of the flints except of course that it did not require calcining. When all the necessary materials had been prepared they were placed in different troughs or tanks, ready for the mixer to draw off what quantity of each material was required.

British and American Methods Compared

In England the custom was to mix in the wet state of so many ounces to the pint, but in the United States the mixing was done with the materials in the dry state and by weight. The whole of the mixture was then placed in an agitator and beaten until it became thoroughly mixed. It then became what was known as a slip, and was again passed over a series of sieves down to 120 mesh—that is, 120 holes to the lineal inch or 14,400 holes to the square inch, which gave some idea of the fineness required. In the manufacture of some of the better class of ware the slip was passed over a series of magnets which extracted any particles of iron, which would naturally detract from the purity of the ware.

When the slip had been thus prepared it was put through a filter press to take out most of the moisture, and put aside in the slip-house, which was usually a dark cellar underground, to "age," and covered over with old filter cloths or similar material, which was moistened from time to time. Many firms in Staffordshire particularly made a speciality of making "slip," which was sold to the smaller potters who do not have the plant or accommodation to make the slip themselves.

Preparation of the Slip

When the slip was required for manufacture, it was placed in a pug mill with a small quantity of water and again given a thorough mixing to bring it into condition for convenient handling. The slip or body now being ready, it was "thrown" by means of the potters wheel—that is, raised into circular forms of different kinds by means of the rotary motion of the wheel and by the action of the fingers, at which the potter was an expert. Another method was moulding, the slip or paste being rolled into flattened pieces which could be easily squeezed into a mould, commonly of plaster of Paris. This was known as pressing. A later method still was "casting," in which the slip of slightly thinner consistency was poured into cast moulds in somewhat similar manner to casting in a foundry, and the mould taken apart when the body had set sufficiently.

In making such things as plates and saucers, these were usually made by machinery which consisted of a spreader and jigger. A lump of the slip was placed under the spreader, which simply spread or flattened it out, and then into the jigger machine, which cut it into shape and at the same time pressed out the form of plate or saucer required.

The various forms having been completed the pieces were placed into what was known as the "green" room, *i.e.*, with the piece in a wet or green state, and allowed to dry. Up to this point it would be seen that the use of water was simply a tool in the process of manufacture, or in other words a means of creating plasticity to be laid aside when no longer required.

In the Kiln

Having been sufficiently dried, the pieces were carefully examined for flaws and placed in large flat-bottomed pans, oval or round as might be considered desirable, with vertical sides of sufficient height. These pans were known as "saggers" and were made of refractory materials, such as fire-clay, broken pieces of earthenware after the first fire, or of broken saggers themselves pounded up. In these saggers the dried pieces were so placed as to allow as many as possible to be packed without injury to each other, and were generally supported on a bed of finely-ground calcined flint.

The saggers were then arranged in the kiln called the biscuit kiln, and piled one above the other. Plates were placed one above the other and supported by spurs or stilts, hence the three pin marks which one usually found at the bottom of the plate. The type of kiln most commonly used in England was the conical or round kiln, and the saggers were placed all over the floor of the kiln, and then piled one on the other up to the roof.

Increasing Use of Tunnel Kiln

The newest type of kiln, and the type now being extensively used in America, was the Dreslier tunnel kiln, which consisted of a long tunnel with the heat concentrated near the centre. This type of kiln was also becoming popular in England, and when new kilns were required the tunnel kiln was being adopted. The nearest kiln of this type was at Candy's pottery, at Heathfield, near Newton Abbot, where they made the Devon fire.

With this type of kiln, the saggers were placed on a trolley and driven forward very slowly into the kiln. The distance the trolley had to travel before reaching the maximum heat allowed the ware to become heated gradually, until it reached the maximum, and after passing that point it gradually cooled until it reached the other end of the kiln, which usually took about 48 hours. These kilns were about 300 ft. long, and the speed of travel was just over 6 ft. per hour. It was, of course, a matter of taste as to which type of kiln was preferred, and some of the older potters in England still stuck to the conical kiln, contending that it turned out much better and more uniform ware, although the process was rather longer, about three days.

The saggers having been withdrawn from the kiln and the contents removed, the ware was then in the condition known as "biscuit," being white and porous and readily absorbing water.

Importance of Uniform China Clay

One very important feature at this point was the shrinkage, or the amount of contraction in firing, which, of course, was due partly to the loss of water and to the ignition of any carbonaceous matters contained in the clays, but more particularly to the drawing together of the particles by vitrification. Due allowance was made for this contraction

by the potter in his mix or formula, the percentage of one material being increased or decreased as the case might be to counteract the other. Without giving away any of the secrets of the China Clay trade he could say that the question of the substitution of clays was therefore one of extreme importance to the potter, and unless he himself was careful enough to make tests before using any of his materials, the substitution of one clay for another was likely to prove disastrous when the results of the biscuit firing were seen.

A Glazing Process

The next step, the glazing of the " biscuit " ware, was done by painting or by transfers from engravings, thus producing printed ware. The colours which could be advantageously used under the glaze were few as compared with those employed above it. In the latter case the paints used were enamel colours. The material of the glaze might vary according to the practice at different places, but it was commonly composed of quartz, flint, felspar, gypsum, borax, boric acid, common salt, potash, soda, China Clay, Ball Clay, and oxide of lead. Coloured glazes were of course obtained by adding metallic oxides, such as those of manganese, copper, chromium, cobalt, etc. Oxide of tin was often used in certain glazes or enamel.

The glaze having been prepared, the earthenware, either plain or painted with colours, was dipped. Upon removal, all traces of the colouring were lost under a thin coating of glaze, the water being readily absorbed by the porous biscuit ware. The ware was now placed in saggers and exposed for about 24 hours in what were called the glost or glost kiln, where it was subjected to temperature lower than in the biscuit kiln, but at the same time sufficiently high to fuse the coating upon the ware and so form a glaze which by its transparency disclosed the painting or printing, while by its imperviousness it prevented the access of liquids to the porous body beneath.

Drying Clay by Endosmosis

Dr. Ormandy's Remarks

A PAPER on " Drying by Pressure," was read by Professor J. W. Hinchley, at the " Conference on Drying " recently organised by the Institution of Chemical Engineers. One of the subjects with which the paper dealt was the removal of water from peat by pressure. In the course of the discussion, Dr. W. R. Ormandy mentioned another system which could be applied to the drying of peat, and which was applied on a large scale on the Continent to Ball Clay and China Clay. The wet clay was placed between two conducting surfaces between which direct current was passed, with the result that the water was ejected by endosmosis. Peat containing 93 per cent. of water could be subjected to this process, and the resultant product, containing from 45 to 55 per cent. of water, would cake, and could be broken up to resemble peat briquettes. The water content of China Clay could be reduced to about 32 per cent., and that of Ball Clay could be reduced to about 28 per cent., in the course of two or three minutes.

Amount of Power Used

Dr. Ormandy stated that the amount of current used when drying by means of electricity was a function of the conductivity of the water. When working with China Clay, and if the water were of good quality, the consumption of electricity, with a voltage of 500, was exceedingly small. It was necessary, however, to add to the clay a certain amount of an electrolyte of a peptising nature, *i.e.*, a silicate of soda solution, or caustic soda or sodium carbonate.

The amount of current employed was sufficiently small to render the utilisation of this process the cheapest method of dealing with China Clay where at the same time it was desired to free the China Clay from impurities which were otherwise exceedingly difficult to remove. At Chodau, in Jugo-Slavia, the China Clay contained from 2 to 3 per cent. of iron pyrites in a fine state of division, and it could not be separated by the usual methods of separation used in the China Clay industry. Although the clay was peptised by the addition of the electrolyte, the iron and sulphide particles did not absorb the alkali, and were not capable of being moved by the electric field.

China Clay Firm's Action

Claim for Damages Against Shipping Agents

BREACH of a charter party was the allegation in a case heard before Judge Gurdon at Plymouth County Court on December 5, and damages amounting to £109 were claimed. Plaintiffs were Grose and Stocker, Ltd., China Clay producers, of St. Austell and Stoke-on-Trent, and the defendant was Mr. Albert Westcott, of Plymouth. Mr. Carlile Davis was for the plaintiffs and Mr. Mayburne Pearce for the defendants.

Mr. Carlile Davis, for plaintiffs, said Grose and Stocker, Ltd., carried on business at Stoke-on-Trent and raised China Clay in the neighbourhood of St. Austell. The claim was for £109 damages for breach of charter party entered into with the agents of the defendant shipowner. Dated March, 1928, the charter party was in respect of a vessel named *Frances and Jane*, then discharging cargo at Torpoint. She was expected to be ready to load at Fowey, between March 17 and 19. 360 tons of China Clay for Sunderland.

Sequel to Collision

The ship was understood to be staunch and seaworthy. Evidence was to be placed before the court, however, that during her previous voyage the *Frances and Jane* had been in collision in the Mersey. In a damaged condition the *Frances and Jane* arrived in Plymouth.

On March 15 a survey was made, and the shipowner's own surveyor estimated that repairs would occupy three weeks. None of these facts were disclosed to Grose and Stocker, Ltd. until they wondered why the ship did not arrive at Fowey. She did not reach Fowey till April 2, was loaded on the 4th, and ought to have sailed that day. The submission of plaintiffs was that the vessel was unseaworthy when the contract was entered into, and that there was then no reasonable expectation that she would be able to fulfil the contract. The *Frances and Jane* did not leave Fowey till April 12, nearly a month later than the contract stipulated. She did not arrive at Sunderland till April 26, which was rather a long time, on account of head winds. Instead of sailing according to charter the ship was 23 days late.

Plaintiffs were under contract to supply paper works at Sunderland with China Clay. Stocks of clay at that mill became very low owing to the non-arrival of the vessel, and in order to fulfil their contract with the paper company plaintiffs had to send consignments to Sunderland by steamer to meet the demand.

Stocks for Paper Mills

Thomas Martin, plaintiffs' manager at St. Austell, said the brokers were given to understand that plaintiffs were under contract to replenish the stock of clay at the paper mills, and that the ship must reach Sunderland about March 25 or 27. As a result of the delay, special consignments had to be sent by steamer, entailing an expenditure by plaintiffs of £109.

Mr. S. E. Hambling, consulting naval architect, Plymstock, who made a survey of the *Frances and Jane*, estimated at £100 the cost of many necessary repairs, which would occupy about three weeks.

Answering Mr. Mayburne Pearce, witness said on March 17 the ship was unseaworthy.

Mr. Pearce submitted that under the contract entered into by plaintiffs with the paper company, if there was any delay by carrier on sea or land, the company could not have called on Grose and Stocker, Ltd., to make good the damages. In this case there was justifiable delay of the carrier.

His Honour intimated that he could not stop the case on the point raised by Mr. Pearce.

Mr. Albert Westcott, Woolster St. Plymouth, owner of the *Frances and Jane*, submitted that under the original charter which came to him, three weeks were allowed to do the repairs, which actually took 14 days, every effort being made to expedite them.

On the second day of the hearing, lengthy legal arguments were advanced, Mr. Mayburne Pearce, for Mr. Westcott, contending that there was no liability on his part.

For the plaintiffs, Mr. Carlile Davis argued that the whole of the damages arose through defendant not acquainting his agents, the shipbrokers, with information as to the extent of the repairs required by his sailing vessel, the *Frances and Jane*, at the time the charter-party was entered into.

His Honour reserved judgment.

China Clay Notes and News

China Clay Rating

THE first official response to the representations made by the China Clay industry on the question of the valuation list submitted by the St. Austell Rural Rating Authority (dealt with in our editorial notes) was forthcoming at the St. Austell Rural Council meeting held on December 7, when the following letter from the Ministry of Health was read :—

"*Rating and Valuation (Apportionment) Act, 1928: Local Government Bill.*

"I am directed by the Minister of Health to refer to your letter of the 26th ultimo, and to say that the Minister understands that the Council's valuer, Mr. Body, has been in communication with the Secretary of the Central Valuation Committee as to the procedure to be adopted in the preparation of the draft special lists to be made under the Rating and Valuation (Apportionment) Act in the case of China Clay hereditaments. While the Minister is not empowered to express any authoritative opinion, he may say that he concurs generally with the advice given to Mr. Body by the Secretary of the Central Valuation Committee, and thinks that, if this advice is followed, no difficulty should arise.

"The Minister does not desire to offer specific comments on Counsel's opinion which you enclosed with your letter, though he does not, as at present advised, accept the conclusions. With regard, however, to the suggested financial effects on the proposed grants to the County or District, I am to state that the Minister's intention is as follows: The figures of rateable value to be used for the purpose of calculating loss of rates will be those appearing in the valuation lists in force on October 1, 1929, but if those figures are shown (as the result of the decision of an objection or appeal outstanding at that date or a proposal for amendment made between that date and March 31, 1930) to have been incorrect at that date, and are altered in the valuation lists in force on October 1, 1929, they will be adjusted retrospectively and the adjusted figures will be used for the purpose of grant calculation.

Further Consideration

"THE Minister fully appreciates the importance to local authorities of this point, and he is advised that the combined effect of the relevant statutory provisions and of the Local Government Bill now before Parliament is to carry out that intention. I am, however, to assure you that the matter will receive further consideration, and if it appears that there is any doubt, steps will be taken to remove it.

"You will probably wish to send a copy of this letter to the China Clay Association, and I am to add that should you or they desire to confer with officers of the Department on this matter an appointment could be made at short notice."

Mr. F. W. Jenkin expressed the opinion that from the letter it appeared that they were safeguarded. There had been a certain amount of fear expressed on that rating and valuation business, but he was satisfied, having heard that letter, that the district would not lose that to which it was entitled. It was a great relief to very many of them.

The Council went into committee to consider the letter, and also other letters from Associated China Clays, Ltd., Mr. Body (the Rural Rating Authority's valuer), and the Central Valuation Committee.

The China Clay industry is also considering the matter further in the light of the Ministry's letter.

Radioactive Pottery

A NEW method of application of radium is reported in a German magazine. Many natural waters have been found to be radioactive, and their presence in the springs of certain resorts has undoubtedly occasioned or added to the fame of these. It has been found that certain clays employed in the manufacture of pottery readily lend themselves to a mixture with radioactive substances without injury to their ceramic qualities, especially the property of being readily moulded and fired. The most important radioactive substances employed are the uranium pitchblende, which is found in considerable quantities in the Joachimstal in Bohemia, and the mineral called Fergussonite, as also the residues remaining from the working of uranium ores. These substances are mixed with the clay, which is then moulded into the desired shape and fired. Certain precautions must be observed, however, during the firing—in especial the clay must be prevented from becoming too much vitrified and contracting too greatly. It must, on the contrary, preserve as large as possible an external surface and thus remain porous in the interior. This is accomplished by a suitable modification of the firing process. The vessels thus prepared are first sprayed with fused aluminium and then receive a thicker layer of metal (copper or brass). When water is poured into a jug thus prepared, it becomes highly radioactive in the course of a few days. Instead of jugs clay tubes can be manufactured in the same manner and simply slipped into ordinary vessels.

China Clay Exports, November, 1928

A RETURN showing the quantities and values of the exports of China Clay, including Cornish or China Stone, the manufacture or produce of Great Britain and Northern Ireland, from Great Britain and Northern Ireland as registered in the month of November, 1928:

COUNTRY OF DESTINATION.	QUANTITY. Tons.	VALUE £
Estonia	1,292	1,733
Latvia	549	936
Sweden	906	2,025
Norway	2,411	4,773
Denmark	738	1,926
Germany	4,606	10,895
Netherlands	6,058	13,885
Java	2	11
Belgium	4,527	7,391
France	2,695	5,239
Portugal	20	81
Spain	2,136	6,094
Italy	1,857	3,772
China	12	61
United States of America	33,164	76,148
Ecuador	6	22
Argentine Republic	2	12
Irish Free State	6	7
Cape of Good Hope	—	3
British India, via Bombay	99	414
Via Bengal, Assam, Bihar and Orissa	280	968
Hong Kong	—	1
Australia	18	196
New Zealand	1	9
Canada	398	1,437
Total	61,783	138,039

China Clay Imports, November, 1928

A RETURN showing the quantities and value of China Clay (including China Stone) imported into Great Britain and Northern Ireland as registered in the month of November, 1928:

COUNTRIES WHENCE CONSIGNED.	QUANTITY. Tons.	VALUE. £
Germany	30	136
U.S. America	56	929
Total	86	1,065

Removing Sulphates from Clay

IN the current issue of the *The Illustrated Official Journal (Patents)* appears an application for a patent by A. L. Mond and the Kali-Chemie Akt.-Ges., on the removal of sulphates from clays, etc. (No. 36,266).

Shipping and Export News of the Month

We give herewith latest particulars relating to arrivals and sailings of ships engaged in the China Clay trade, at the principal British clay ports. Registered exports of China Clay, with countries of destination, and other shipping and export matters are dealt with.

Fowey Shipping—November, 1928

Arrived.	Name.	Sailed.	Destination.
November 1,	S.S. *Blush Rose*	November 2,	Newport
November 2,	S.S. *Totnes*	November 3,	Gravelines
November 1,	S.V. *The Sirdar*	November 2,	Plymouth
November 1,	S.S. *Pylades*	November 3,	Methil
November 1,	S.S. *Gronant Rose*	November 6,	Brussels
November 1,	M.V. *Isabel*	November 1,	Par
November 1,	S.V. *W. E. Gladstone*	November 5,	Mevagissey
November 1,	S.S. *Cambalu*	November 6,	Antwerp
November 1,	S.S. *Marta*	November 5,	Gothenburg
November 1,	S.S. *Rayford*	November 6,	Antwerp
November 3,	S.S. *Joffre Rose*	November 10,	Runcorn
November 3,	S.S. *Dorrien Rose*	November 8,	Preston
November 3,	S.S. *Hayle*	November 10,	Runcorn
November 3,	S.V. *Hilda*	November 12,	Charlestown
November 4,	S.S. *Mersey*	November 9,	Plymouth
November 4,	S.S. *Sturdee Rose*	November 9,	Weston Point
November 4,	S.S. *Ida*	November 10,	Antwerp
November 4,	S.S. *Bracondale*	November 10,	Norfolk, Va.
November 4,	S.S. *Colon*	November 9,	Genoa
November 5,	S.S. *Torfrid*	November 9,	Odense
November 5,	S.S. *Solskin*	November 9,	Wargon
November 7,	S.S. *Blush Rose*	November 12,	Runcorn
November 7,	S.S. *Edern*	November 12,	Glasgow
November 7,	S.S. *Amstelstroom*	November 13,	Amsterdam
November 8,	S.S. *Farfield*	November 12,	Grimsby
November 8,	M.V. *Lydia Cardell*	November 26,	Garston
November 8,	S.S. *Cewea*	November 13,	Hamburg
November 8,	M.V. *Monica M.*	November 9,	Pentewan
November 10,	M.V. *Kathe Jurgensen*	November 13,	Hamburg
November 10,	S.S. *Niord*	November 14,	Drammen
November 10,	S.S. *Guelder Rose*	November 13,	Preston
November 11,	S.V. *Albert*	November 27,	Stettin
November 11,	S.S. *Goldfinch*	November 13,	Birkenhead
November 12,	S.S. *Mount Charles*	November 13,	Lancaster
November 13,	S.S. *Allanwater*	November 15,	Antwerp
November 13,	S.S. *Pansy*	November 14,	Bo'ness
November 14,	M.V. *Caroline*	November 20,	Reval
November 15,	S.S. *Beauport*	November 17,	La Pallice
November 15,	S.S. *Gouwestroom*	November 17,	Amsterdam
November 15,	S.V. *Harris*	November 24,	Stettin
November 16,	S.S. *Soborg*	November 20,	Philadelphia
November 17,	S.S. *Hofuku Maru*	November 27,	Portland Me.
November 18,	S.S. *Southwell*	November 22,	Pasages and Bilbao
November 18,	S.S. *Lackenby*	December 1,	Portland Me.
November 18,	S.V. *Nordtrafik*	November 27,	Marstal
November 18,	S.V. *Rothersand*	November 20,	Par
November 18,	S.S. *Ravenscraig*	November 23,	Newcastle
November 19,	S.S. *Mersey*	November 23,	Ridham
November 19,	S.S. *Joffre Rose*	November 27,	Runcorn
November 19,	S.S. *Hematite*	November 23,	Antwerp
November 20,	S.S. *Farfield*	November 27,	Preston
November 20,	S.S. *Ribblebank*	November 24,	Liverpool
November 20,	S.S. *Ribblebank*	November 24,	Liverpool
November 21,	S.S. *Porthmeor*	November 24,	Leith and Aberdeen
November 22,	M.V. *Hawarden Castle*	November 26,	Par
November 22,	M.V. *Romonie*	November 24,	Par
November 23,	S.S. *Florentino*	November 27,	Genoa
November 24,	S.S. *Lake Gorin*	December 4,	Boston Mass.
November 26,	S.S. *Ariosto*	December 1,	Bombay and Karachi
November 26,	S.S. *Konigsau*	November 29,	Harburg
November 27,	S.S. *Jellicoe Rose*	November 29,	Antwerp
November 27,	S.S. *Fowey Rose*	November 30,	Ridham
November 27,	S.V. *Hilda*	November 30,	London
November 28,	M.V. *Neptunus*	December 1,	Oscarshaven
November 28,	S.S. *Primrose*	December 5,	Rouen
November 29,	S.S. *Hayle*	December 4,	Manchester
November 29,	S.S. *Blush Rose*	December 4,	Preston
November 29,	S.S. *Sturdee Rose*	December 3,	Brussels
November 29,	S.S. *Derbyshire*	December 4,	Rangoon
November 29,	S.S. *Pansy*	December 3,	Leith
November 29,	S.V. *Falker*	December 5,	Aarhus
November 29,	S.S. *Cornish Rose*	December 5,	Terneuzen
November 29,	S.V. *Frances Jane*	December 6,	Hull

Par Harbour Shipping—November, 1928

Arrivals

Date.	Vessel.	From
November 1,	M.V. *Amazon*	Porthhoustock
November 2,	S.S. *Clyde Firth*	Hayle
November 2,	M.V. *Isabel*	Plymouth
November 8,	S.S. *Robrix*	Truro
November 8,	M.V. *S. F. Pearce*	Falmouth
November 10,	M.V. *Monica M.*	Pentewan
November 13,	S.V. *Kate*	Falmouth
November 13,	M.V. *Isabel*	Porthoustock
November 18,	M.V. *Katie*	Mevagissey
November 20,	S.V. *Rothersand*	Falmouth
November 24,	M.V. *Romanie*	Gijon *via* Fowey
November 25,	S.S. *Culmore*	London
November 26,	M.V. *Hawarden Castle*	Fowey
November 27,	S.S. *Jolly Bruce*	Guernsey
November 27,	S.S. *Christinna*	Southampton
November 26,	S.V. *Ryelands*	Looe
November 27,	M.V. *Rottum*	Antwerp
November 28,	S.S. *Bangor*	Middlesbrough
November 30,	S.S. *Treleigh*	Portreath
November 30,	S.S. *Grosvenor*	Shoreham
November 1,	S.S. *Knowlgrove*	Tayport
November 2,	S.S. *Jolly Marie*	Gravesend
November 2,	S.S. *Rayford*	Fowey
November 3,	S.V. *Lucy*	Goole
November 3,	M.V. *Romanie*	Dijon
November 3,	M.V. *Amazon*	Pentewan
November 3,	S.S. *Clyde Firth*	London
November 7,	M.V. *Prinsessan*	Plymouth
November 8,	M.V. *Isabel*	Queenboro
November 10,	S.S. *Robrix*	London
November 14,	M.V. *S. F. Pearce*	Rochester
November 18,	M.V. *Monica M.*	Rochester
November 18,	M.V. *Isabel*	Pentewan
November 26,	S.S. *Kate*	Poole
November 27,	M.V. *Katie*	London
November 27,	S.V. *Rothersand*	Kirkcaldy
November 28,	M.V. *Romanie*	Rouen
November 28,	S.S. *Culmore*	Dartmouth
November 29,	M.V. *Hawarden Castle*	Ternuezen
November 30,	S.S. *Jolly Bruce*	London
November 30,	S.V. *Ryelands*	Runcorn

Charlestown Shipping—November, 1928

Arrived.	Vessel.	From.	Sailed.	Destination.
October 29, M.V.	*Jane Banks*	Glasgow	November 10,	Newcastle
November 1, S.S.	*Eastoft*	Salcombe	November 2,	Methil
November 5, M.V.	*James M*	Southampton	November 8,	Snodland
November 7, S.V.	*Lady Jean*	Plymouth	November 13,	Rochester
November 9, S.S.	*Stanwell*	London	November 10,	Aberdeen
November 9, S.V.	*Elsa*	Cardiff	November 26,	Nantes
November 10, S.V.	*Lady Daphne*	Truro	November 18,	Rochester
November 10, S.S.	*Weston*	Plymouth	November 13,	Leith
November 12, S.V.	*Hilda*	Goole	November 27,	London
November 14, M.V.	*Mary B. Mitchell*	Truro	Novemner 18,	London
November 14, M.V.	*Agiena 2*	Truro	November 20,	Rochester
November 18, S.V.	*Snowflake*	Mevadissey	November 26,	Runcorn
November 18, S.V.	*Waterwitch*	Falmouth	November 26,	Runcorn
November 20, S.V.	*Clymping*	Truro	November 28,	London

Penzance Shipping—November, 1928

Arrived.	Name.	Sailed.	Destination.
October 29,	*Mary Barrow*	November 14,	Rochester
November 1,	*Amenity*	November 4,	Northfleet
November 5,	*Guelder Rose*	November 10,	Fowey
November 11,	*Brier Rose*	November 13,	Ridham
November 13,	*Pet*	November 28,	Dundee
November 29,	*Johannes*	December 1,	Kotka (Baltic)

Par Harbour Tide Table, January, 1929

(Greenwich Mean Time Throughout.)

Day of Week.	Day of Month.	Morning.	Afternoon.	Height.
Tuesday	1	9.27	9.43	11.5
Wednesday	2	10.6	10.29	10.9
Thursday	3	10.53	11.20	10.3
Friday	4	11.50	—	9.11
Saturday	5	0.22	0.56	9.11
Sunday	6	1.30	2.3	10.1
Monday	7	2.35	3.5	10.6

Day of Week.	Day of Month.	Morning.	Afternoon.	Height.
Tuesday...	8	3.34	4.0	10.11
Wednesday	9	4.24	4.45	11.3
Thursday..	10	5.5	5.25	11.7
Friday ...	11	5.45	6.4	11.8
Saturday .	12	6.22	6.40	11.10
Sunday ...	13	6.57	7.13	11.11
Monday ..	14	7.29	7.46	11.11
Tuesday...	15	8.3	8.21	11.9
Wednesday	16	8.39	8.57	11.7
Thursday..	17	9.17	9.39	11.4
Friday ...	18	10.2	10.20	11.0
Saturday .	19	10.52	11.21	10.8
Sunday ...	20	11.54	—	10.5
Monday ..	21	0.30	1.9	10.7
Tuesday...	22	1.50	2.30	11.2
Wednesday	23	3.7	3.42	11.11
Thursday..	24	4.14	4.44	12.8
Friday ...	25	5.13	5.41	13.2
Saturday .	26	6.8	6.32	13.4
Sunday ...	27	6.54	7.15	13.5
Monday ..	28	7.35	7.54	13.3
Tuesday...	29	8.13	8.32	12.9
Wednesday	30	8.50	9.7	12.2
Thursday..	31	9.25	9.44	11.5

E. CLEMENS, Harbour Master.

November Deliveries

Up by Nearly 10,000 Tons

THERE was a big jump in the turnover of business done in November, which is all the more surprising in view of the interference with shipping through severe gales. A satisfactory feature of the turnover is that China Clay was responsible for the whole of the increase of just under 10,000 tons over October deliveries. Details :—

Port.	China Clay. Tons. 1928.	China Clay. Tons. 1927.	Stone. Tons. 1928.	Stone. Tons. 1927.	Ball Clay. Tons. 1928.	Ball Clay. Tons. 1927.	Total. Tons. 1928.	Total. Tons. 1927.
Falmouth	265	1,240	—	—	—	—	265	1,240
Fowey	63,333	76,002	3,469	4,521	1,659	1,796	68,461	82,319
Looe	382	—	—	—	—	—	382	—
Penzance	2,149	2,000	—	—	—	—	2,149	2,000
Par	4,488	5,572	105	47	—	—	4,593	5,619
Plymouth	1,588	3,896	—	—	—	—	1,758	3,896
Charlestown ..	3,828	5,230	—	—	—	—	3,828	5,230
By rail	4,937	4,661	—	—	—	—	4,931	4,661
	81,137	98,601	3,574	4,568	1,659	1,796	86,370	104,965
November, 10 mths. ...	663,244	734,051	41,890	47,059	22,281	19,853	727,415	800,963
11 months	744,381	832,652	45,464	51,627	23,940	21,649	813,785	905,928

China Clay Matters in Parliament

IN the House of Commons, on December 3, Mrs. Runciman asked the President of the Board of Trade what was the amount of China Clay mined in Cornwall in 1927; what was the amount of Cornish China Clay exported in 1927; and which were the chief countries to which these exports were made in the same period?

Mr. H. Williams replied that the total quantity of China Clay produced in Cornwall during 1927 was 801,500 tons. In addition, 63,612 tons of China Stone were produced. The total exports of British China Clay (including Cornish China Clay or Stone) during 1927 were as follow:

Consigned to:	Tons.
Germany	33,885
Netherlands	50,712
Belgium	65,428
France	28,975
United States of America	319,138
Other foreign countries	112,100
Total to foreign countries	610,238
British India	36,581
Other British countries	9,017
Total to British countries	45,598
Total	655,836

Most of these exports consisted of Cornish China Clay and Stone, since the only other production of China Clay in Great Britain in 1927 (namely in Devon) amounted to 67,732 tons.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

Mortgages and Charges

[*NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case, the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.*]

COALVILLE BRICK CO., LTD.—Registered November 2, £250 debentures, part of £5,000; general charge. *£1,950. October 18, 1928.

DAVIGDOR ROAD TILE WORKS (HOVE), LTD. (late CANTLEY, DEAN AND GUNNING, LTD.).—Registered November 10, £5,000 debenture, to J. H. Pashley, 16, Denmark Terrace, Brighton, director; general charge. *——. August 11, 1928.

WOODCOTE BRICK AND TILE WORKS, LTD.—Registered November 13. £450 mortgage, to Reading and County Permanent Benefit Building Society; charged on Greenmoor Cottage, Greenmoor Hill, Woodcote. *Nil. April 24, 1928.

Satisfactions

ALDERS PAPER MILLS, LTD., Tamworth.—Satisfaction registered November 23, £30,000, registered November 19, 1925.

COALPORT CHINA CO. (JOHN ROSE AND CO.), LTD., Stoke-on-Trent.—Satisfaction registered November 8, £5,500, part of amount outstanding July 1, 1908.

EBURITE PAPER CO., LTD., London, N.W.—Satisfaction registered November 20, £30,000, registered April 18, 1923, and £10,000 registered November 27, 1924.

PERRETT'S BRICK AND TILE CO., LTD., London, W.C.—Satisfaction registered November 15, £2,500, balance of amount registered April 12, 1922.

WEDGWOOD AND CO., LTD., Brownhills (Staffs), earthenware manufacturers.—Satisfaction registered November 13, £7,000, part of amount outstanding July 1, 1908.

London Gazette, &c.

Companies Winding Up Voluntarily

ST. LEONARDS TILE CO., LTD.—At an extraordinary general meeting of the members of the above named company, held at Palace Chambers, Hastings, Sussex, on November 29, 1928, the following extraordinary resolution was duly passed:

"That it has been proved to the satisfaction of this meeting that the company cannot, by reason of its liabilities, continue its business, and that it is advisable to wind up the same, and accordingly that the company be wound up voluntarily; and that Mr. Francis Charles Gibbons, of Palace Chambers, White Rock, Hastings, Sussex, chartered accountant, be hereby appointed liquidator for the purpose of the winding-up."

WEYMOUTH BRICK CO., LTD.—At an extraordinary general meeting of the members of the above named company, held at 2, Down Villas, Rodwell, Weymouth, Dorset, on November 14, 1928, the following special resolution was duly passed; and at a subsequent extraordinary general meeting of the members of the said company, also duly convened, and held at the same place on November 29, 1928, the following special resolution was duly confirmed:—

"That the company be wound up voluntarily; and that Arthur Essex Clayton, of 47, South Street, Dorchester, chartered accountant, be and he is hereby appointed liquidator for the purpose of such winding-up."

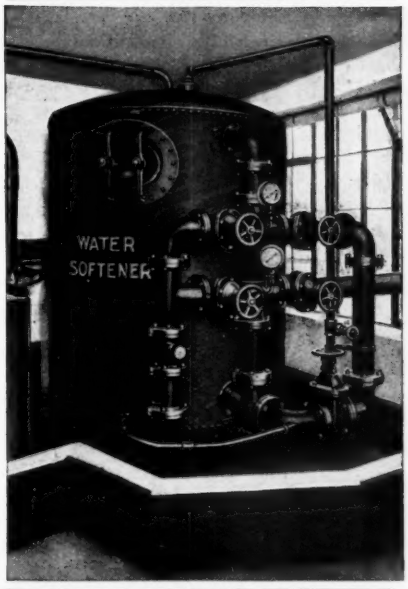
Exports and Imports

THE usual tables of exports and imports will be found on the "Notes and News" page (page 8).

The Dyestuffs Monthly Supplement

A Section devoted to the Manufacture and Use of Dyes Published in THE CHEMICAL AGE the Second Week of each Month

The OPINION of Engineers & Chemists



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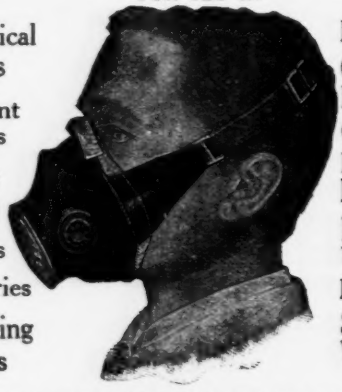

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SOME REVIEWS:

"The Chemistry of Drugs" is the first book to treat the subject in the light of modern research . . . the author may be congratulated . . . the book will prove a valuable work of reference. . . . The whole of the work has been done with great judgment."—PHARMACEUTICAL JOURNAL.

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Dyestuffs Monthly Supplement

Published in the second issue of "The Chemical Age" each month

Communications relating to editorial matter for the Dyestuffs Monthly Supplement should be addressed to the Editor, THE CHEMICAL AGE, *Bouverie House, 154, Fleet Street, London, E.C.4. Advertisement matter, subscriptions, etc., should be sent to the Manager. The Supplement is devoted to the interests of both manufacturers and users of dyestuffs, and contributions will be welcomed.*

The Dyers' Strike

THE settlement of the dispute in the dyeing trade has been received with satisfaction on all sides, and by this time work has been generally resumed. The public are not directly interested in the differences between the technicalities of piece time rates and standard rates, but everyone is agreed that in the present condition of the textile trade, further trouble in the dyeing branch would be disastrous.

Autumn Shades

IMPERIAL CHEMICAL INDUSTRIES, LTD. issue an attractive B.D.C. card of fashion shades for the coming autumn. These are described as "only a few suggestions," and the company offer to give recipes for the matching of any other desired shade on wool or any other material. The dyeing of the eight colours shown is carried out in the manner usual for acid colours, with the addition of 10 per cent. Glauber's salt and 2 per cent. sulphuric acid. The colours are distinguished for great delicacy of tone. The names chosen are Wisteria, Mayonnaise, Ariel, Prawn, Submarine, Pebble, Greenstone, Saracen Red, Lomond Blue and Chocolate.

The Dyestuffs Licensing System

THERE is one point in Mr. Sutcliffe Smith's review of the British Dyestuffs industry with which dyestuff merchants will find themselves heartily in accord. When an application is made to the Licensing Committee to import a foreign colour on the ground of price difference, the applicant has to furnish particulars of the foreign supplier's quotation, and this quotation is furnished to the British makers. The latter are thus made aware of the exact cut it is necessary to make in their own figures in order to keep out the rival product, and this has often been criticised by importers as resembling a disclosure of estimates received from one firm to competitive firms who were also tendering. Mr. Sutcliffe Smith's proposal is that foreign quotations accompanying an application on price grounds should be disclosed only to the chairman and neutral members of the Licensing Committee, and that British makers should be free to quote competitive prices without exact knowledge of the foreign quotation. The present procedure, of course, tends to favour the British maker, as indeed the Dyestuffs Act itself does, for it was passed for the purpose, but the present objection is that it extends the functions of the Act beyond the legitimate limits, and makes the price competition with foreign firms rather artificial.

Dyestuff Statistics

ANOTHER point of interest is the proposal to transfer the statistical work of the Dyestuffs Development Committee to the Board of Trade. In response to repeated applications, the Committee now publish certain statistics of British dyestuffs production, but this information is very scanty compared with the large volume issued by the United States Tariff Commission and known as the Census of Production. This volume is one of international interest. Its compilation and publication is obviously a rather costly business, and the issue of a similar survey by the Board of Trade would involve a substantial item of expenditure. Apart from the cost, there can be no conceivable objection to the publication of a British Census of Dyestuffs Production, but those responsible for departmental expenditure will probably require considerable pressure to induce them to undertake this new liability.

The Question of Repeal

THE most significant passage in Mr. Sutcliffe Smith's speech was his frank allusion to the question of the repeal of the Dyestuffs Act when it expires in 1930. When it was passed, its operation was specifically limited to ten years and no longer, but the tendency of late has certainly been not to relax any means of safeguarding home industries, and unless it could be said that the British industry was able to meet world competition out of its own resources there would be a strong demand in certain quarters for the extension of the Act for a further limited period. On the other hand, it would be argued with equal zeal that sacrifices had been made to give the industry a specially safeguarded position for ten years on the assumption that that was a fair period within which it might be established. The issue, however, will probably be decided on the practical ground that a dyestuffs industry is a necessity to this country, that within ten years it has made astonishing progress, and that its future safety cannot advisably be imperilled. Mr. Smith, himself, while discussing the possibility of repeal quite frankly, apparently has in view the need of some compromise, for he asks that the makers and users should confer together on the point and try to agree on some common policy.

Services of Foreign Makers

THERE is one more significant point in Mr. Sutcliffe Smith's speech which some may read with a little surprise. That is his tribute to the services that foreign dyestuff makers still render the trade. This, of course, is no disparagement of the home industry, the progress of which he acknowledged in generous terms; at the same time it is notable that he should have selected the German I.G. and also the Swiss dyestuffs firms for a striking compliment to their technical service. This, he assures us, has been excellent, not only in actual deliveries of colour but in placing at the trade's disposal the benefits of their extensive technical research. They have, in his opinion, not competed unfairly with British makers nor in any way exploited the situation in their own interests. In this matter of technical advice the German makers have long enjoyed a good reputation, and there can be no doubt that the withdrawal of this advice was felt in the British textile trade. More than once it has been suggested that British firms might do a little more to emulate the German example in this respect.

New American Colour Card

A NEW revised edition of the Standard Colour Card of America has been issued by the Textile Colour Card Association. This new edition is the result of thirteen years of experience and study of the colour requirements of American industry. As a dictionary of commercial colours, the card is regarded as of great value to all engaged in the colour industry. The colours number 192, and are arranged in family groups. Forty-four colours that appeared in the previous edition have been discarded because they had become commercially obsolete, and several colours have been "modernised." In classifying

the colours, all blues, or reds, or greens are not placed together, in order to avoid discordance between the different degrees of the quality of each colour. For instance, bluish reds are separated from yellowish reds; yellow greens from greyish and bluish greens; greenish blues from purple blues, and so on, because, if placed together, they would clash. By this division the individual qualities of the colour groups are supposed to stand out more distinctly. Through the arranging of colour families in analogous gradation, the value of each shade is emphasised. As usual, each colour is identified by a cable number and name.

A Primitive Dyestuff

In his pamphlet, one of the Woodbrooke Essays, on *A Primitive Dyestuff* (W. Heffer and Sons, 2s.). Dr. Rendel Harris gives some interesting notes and reflections on the woad plant, the earliest dye-plant known in this land and perhaps in any land. When the art of dyeing with woad became one of our leading industries, it was the custom to treat the blue dye with an alkaline or ammoniacal liquor or lye, which changed the blue into a vivid green, known to the ancients as Lincoln Green, such as Robin Hood and his men wore in the recesses of Sherwood Forest. Cæsar, in his history of the Gallic Wars, describes the Britons as dyeing their bodies with woad, "a substance that yields a bluish pigment and in battle greatly increases the wildness of their look." Up to a few years back the woad plant was still cultivated in Lincolnshire and other parts, but the old race of nomadic woadmen, a kind of agricultural gipsy class, has practically disappeared.

A Surviving Woad Farm

At the end of the pamphlet are some notes on a visit paid last year to what is believed to be the one woad farm now remaining in England, the Woad Farm, Skirbeck. Boston, Linc. Mr. Tom Booth, who is in charge, is descended from woadmen on his mother's side, and the farm belonged originally to his uncle, Mr. Greaves, a prosperous woad grower of his day. According to Mr. Booth's statement to the author, woad is always pronounced "wod," only the leaves are used for the dye, only leaves of first year plants are of use, the crop exhausts the soil, the best crop to follow woad is corn, and wheat that succeeds a woad crop is a peculiarly deep golden colour.

The author, during his visit, had the pleasure to see the woad crushed and prepared for the market. The wood was cut by women and girls, carted to the farm, and ground straight away. The mill, worked by an engine, consisted of three large revolving wheels that described a circle, and two running flanges, one on the outer and one on the inner rim of the wheel track that kept the woad in place. The leaves were piled within the circle and pitched under the wheels a little at a time by two men who then brushed all stray leaves on to the track. The crushed woad was put into two wooden vats. A pipe carried away any juice that ran out, as this is not of use. The next day the woad was made into balls by hand; and these balls were laid out on racks where they would stay until the following December. Then all the woad would be packed into casks and sent to Leeds, where it passes into the hands of the dye-merchant and the dyer. The Government still insists on certain cloth for its use being dyed with woad—hence the order from the firm in Leeds.

Light-Fastness Tests

The report of the sub-committee on Light Fastness of the Research Committee of the American Association of Textile Chemists contains a large amount of information derived from experiments, but it still leaves a number of factors in a doubtful state. In the tests arranged, twenty selected dyeings were exposed to sunlight without glass cover and under window glass, Corex, Vita, and six other special glasses of known transmission. Some of the samples faded considerably more when exposed without glass than when under window glass, and others faded somewhat less without the glass. This was to be expected because the dyeings were chosen from among those which showed the greatest divergence in behaviour when exposed without glass and under glass in previous experiments, in which some 1,200 dyeings were tested. There was a tendency for those dyeings which faded more without glass to fade more under Corex glass and under Vita glass than under window glass. However, fourteen samples faded to the same extent under Vita glass and under window glass, and only four faded decidedly more under Vita glass. Thus the additional ultra-violet radiation transmitted by Vita glass had no appreciable effect on the majority of the samples. It was a large factor in the fading of four of them. The wide variability in intensity of this short wave ultra-violet might introduce serious variations into the results of tests under Vita glass. Window glass, which absorbs this part of the spectrum, would reduce this.

Indigo on Cotton

Some dyeings faded much less when some or all of the ultra-violet in daylight which passes through window glass was prevented from reaching the samples. Other samples, however, faded practically as much under the Noviol O glass, which absorbs the ultra-violet, as under window glass. These samples must have been faded principally by visible radiant energy. The red end of the visible spectrum (and infra-red) is shown to have practically no fading action on more than half of the samples for the exposures given, and relatively little on the others with the exception of Indigo on cotton. The anomalous behaviour of Indigo on cotton became quite evident in the tests. It faded to nearly the same extent under all of the glasses, even though the quality and quantity of the radiation received were obviously different. This is in accordance with the experience of other investigators. Gordon observed that Indigo faded more from some constituent of the atmosphere in contact with his samples than from strong radiation. Cady has obtained similar results. Earlier investigators were not aware of this behaviour of Indigo, and proposed its use as a standard of fastness. It is obvious that the atmosphere about the samples rather than the quality of the light played a dominant part in the fading of Indigo on cotton. How far this atmospheric effect modified the photochemical fading of the other dyeings in the series is not known. It may appear strange that certain dyeings should fade less without glass than under glass, since they receive more light without the glass. It is well known, however, that a photochemical reaction which is produced by one part of the spectrum may be counteracted by another part of the spectrum. This need not be the only explanation. Differences in the temperature or composition of the atmosphere may also be factors.

Textile and Research Work

With the object of assisting the further development of the research work of the Textile Industries Department, the Clothworkers' Company is making an additional grant to Leeds University at the rate of £3,000 a year for the next four years. Since the foundation of the Yorkshire College, donations and annual grants of more than a quarter of a million pounds have been received from the Company. The new building will be officially opened in October. It will allow of extension of the Textile Museum, improved laboratories for the Silk Research Association, and the extension of the mechanical and scientific equipment of the Textile Industries Department. The new grant of £3,000 a year will allow of additions to the research staff, and of the award of a number of post-graduate fellowships or scholarships for research in both the Textile Industries and the Dyeing Departments.

Colour Users and the British Dyestuffs Industry

By H. Sutcliffe Smith

We give below the substance of the important review of the British Dyestuffs industry, from the point of view especially of the home colour user, contained in the address by Mr. H. Sutcliffe Smith (chairman) at the annual meeting of the Colour Users' Association in Manchester on June 29.

DURING 1927, 7,700 licence applications have been dealt with, and the following is a summary of the quantities and values of the licences granted during the period from the commencement of the Committee in 1921 to the end of 1927, for which figures I am indebted to the Board of Trade.*

These figures are not a full record of the importations during the period under review, as down to the end of 1924, reparation colour was imported for which no licences were granted. The figures since 1925, however, may be taken as representative of the total imports.

The licences granted during last year show a large increase over the previous years. Without full information in regard to the output and consumption of colour in this country, it is very difficult to form conclusions even from the figures furnished by the Dyestuffs Advisory Licensing Committee. In 1927 the production of dyestuffs in the United Kingdom showed an increase over 1926 of 9,254,756 lb., or an increase of 30 per cent. The licences granted in the same period showed an increase of 757,769 lb., or 18 per cent.

These remarkable increases must afford considerable satisfaction to the colour-making industries as showing the upward progress in the use of colour, and notwithstanding so much talk about depression in trade, particularly in the textile industry, it is is gratifying to learn that the consumption of colour has an upward tendency.

MR. H. SUTCLIFFE SMITH

Licensing Procedure Requires Modification

The procedure for dealing with applications for licences, in my opinion, requires some modification, and if it were altered on the lines I am now about to suggest, I feel sure it would remove a continual source of irritation, not only to users but to suppliers as well.

When an application is made to the Committee to import foreign colour on the question of a price difference, the applicant is required to furnish particulars of the foreign supplier's quotation. This is a perfectly fair request and one at which no one can cavil. The Licensing Committee, however, report this quotation to the British makers who are thus given an opportunity of meeting the competitor's price down to the two times pre-war price if they desire to do so, and this is the form of protection arising out of the operation of the Act.

It appears to have been the policy of the British makers in the majority of such instances to meet the foreign competitor's price, but, with every desire to assist the British maker. I hardly think that this is quite an equitable procedure, or, to say the least, fair to our foreign suppliers. Obviously, if a foreign competitor realises that his price is simply to be used as a means of forcing a reduction on the part of the British makers, he will refuse to continue to quote and the result will be that the British user will be deprived of competitive prices in a highly protected market.

I suggest that it would be a much fairer procedure if foreign quotations accompanying an application on price grounds were disclosed only to the chairman and neutral members of the Committee, and that if the British makers desired to quote competitive prices, they should furnish their prices also to the members of the Committee, leaving it to the latter to make the final award in regard to the licence. I feel sure that this matter only requires to be ventilated to be adjusted on the lines I am now proposing.

Safeguarding of Industries Act

The only chemical of direct interest to the members that has come under review during the past year is oxalic acid, and the extension of time for a further year during which this chemical is excluded from the operation of the Act has been granted. I do not think it is quite satisfactory that articles should be removed from the list for a limited period only, as this involves close vigilance on the part of consumers at the end of each period to make certain that there are no debatable additions to the list. I think it would be better procedure if the present list were kept intact until such time as an application is made by British manufacturers for further additions, provided, of course, that there is ample opportunity for the facts to be examined by all interested parties before any changes are actually made.

There is one chemical of considerable importance to our members, namely, formic acid, which, in my opinion, is not quite fairly included in the schedule of chemicals applicable to the operations of the Safeguarding Act.

I am well aware, of course, that this is a synthetic organic chemical, but so far as I know, there is only one manufacturer in this country, and I am doubtful whether the British output is sufficient to meet the country's demands. The net result of the operation of the Act in this case is that the British user is paying more than his continental competitor for this important acid.

Dyestuffs Industry Development Committee

As you are aware, this committee was appointed under the Dyestuffs Act, to advise the Board of Trade as to the efficient and economical development of the dyemaking industry, and, when all the negotiations that took place prior to this enactment have been kept in mind, the establishment of

*LICENCES GRANTED.

Year.	For importation from Germany. lb.	Value. £	For importation from Switzerland. lb.	Value. £	For importation from other sources. lb.	Value. £	Total. lb.	Value. £
1921	671,032	197,466	1,796,754	763,299	209,719	82,056	2,677,505	1,042,821
1922	1,325,671	375,675	1,638,235	694,740	270,987	33,404	3,234,893	1,103,819
1923	1,817,571	493,499	1,412,616	459,861	461,253	36,177	3,691,440	989,537
1924	1,805,145	398,226	1,191,931	363,513	39,158	9,204	3,036,234	770,943
1925	2,175,262	334,749	1,157,270	307,754	66,522	9,081	3,399,054	651,584
1926	2,949,858	599,157	1,190,951	333,448	91,778	11,402	4,232,587	944,007
1927	3,644,152	710,938	1,230,815	306,595	115,389	16,480	4,990,356	1,034,013

this committee by statute was undoubtedly a sound one, and good and cogent reasons could then be furnished for its formation.

I am afraid, however, that the committee has not been enabled, owing to its lack of executive power, to fulfil its primary object of endeavouring to secure the manufacture in this country of as many varieties and types as possible of the dyestuffs required by consumers on the most economical basis. I fail to see how the committee, without these powers, is able to influence the progress and development of the dyemaking industry. There is considerable goodwill between the makers and the users, but the development of the industry is largely dependent upon closer working arrangements between the manufacturers in this country on the lines of the recent amalgamations in the heavy chemical industry. When these arrangements have been perfected, I am confident that the goodwill on the part of the users can be made effective for closer arrangement in regard to present and future requirements. It seems to me, therefore, that progress lies along that direction. May I also suggest that the statistical work of the committee be transferred to the Board of Trade, and that it be fully authorised to furnish the most complete and fullest information in regard to the importation and manufacture of all the dyestuffs used in this country on similar lines to the Census of Production issued by the U.S. Tariff Commission. If that were done, then I believe definite progress might be made, but it seems to me truly impossible for the situation to be properly visualised owing to the lack of accurate statistics and information.

Progress of the Dyestuffs Industry

Notwithstanding some complaints by users, particularly in regard to the prices of colours, I have no hesitation in stating that the British dyemaking industry continues to make steady progress. When it is borne in mind that in 1913 Great Britain produced only about 5,000 tons of aniline dyes, which was equivalent to 3 per cent. of the world's production, whereas in 1927 the production amounted to 17,657 tons, which is about 10 per cent. of the present world production, and that Great Britain is now taking its place amongst the leading manufacturers of fast dyestuffs and colours for artificial silk, it will be realised that amazing progress has been made; in fact, so great that I doubt whether it has been excelled during the past decade by any other industry in this country. One has only to study the history of industrial progress in Germany during the past fifty years to realise what an enormous influence the synthetic dyestuff industry has had in its development, and there is no doubt that this can be traced to the influence of the chemical and engineering experience accumulated in the manufacture of dyestuffs.

To cite one important instance to corroborate my point, let me refer to nitric acid, a chemical used to a very large extent in the dyestuffs industry. For a long time the only source of nitric acid was from Chilian saltpetre. It has been known from the experiments of Cavendish that nitric oxides could be formed by the electric arc, and a process based on this observation was first installed in Norway, but the German dyestuffs industry was soon associated with this development. This naturally directed attention to alternative methods of producing nitric acid from the nitrogen of the air. One of the routes explored and pursued was the combination of nitrogen and hydrogen to form ammonia, followed by the subsequent oxidation of ammonia to nitric acid, and this was energetically developed and is now worked on an enormous scale in many countries. Probably all the nitric acid used by the German dyestuffs factories is made from ammonia which has been prepared from the nitrogen of the air, and it is reassuring to industrialists to know that this country is not lagging behind in similar developments. I am referring, of course, to that wonderful plant which the Imperial Chemical Industries have established at Billingham. I make bold to suggest that if this country is to retain its industrial supremacy and to keep in the forefront of progress in the industrial world, particularly on the engineering and chemical sides, it is absolutely essential that the dyestuffs manufacturing industry should be maintained on an adequate scale in this country, as I believe we are on the eve of striking chemical developments which will have far-reaching effects in many of the chemical products necessary for the whole industrial world.

Need for Closer Co-operation

How can still greater progress be made in the production of dyestuffs in this country? I venture to suggest that the time has arrived for a closer merging together of the British dyestuff manufacturing interests. It seems to me that there is far too much overlapping, and that if the industry were "rationalised," greater progress could be made in the standardisation of dyes and in the introduction of new colours. That, of course, was one of the objects of the Development Committee, but, unfortunately, experience has shown that definite progress in that direction cannot be made by this committee.

I am glad to see that the question of co-ordinating manufacturing policy and of keeping abreast of modern developments are matters which are having the serious consideration of Imperial Chemical Industries, and the references to this matter by Sir Harry McGowan at a recent meeting of the shareholders of that company are reassuring. The policy of that company in collaborating with their large customers in order to obtain prior knowledge of their respective requirements is of prime importance, and should be the means of eliminating the peaks of supply and demand so often experienced in the past, due to lack of information and to the absence of co-ordination of kindred interests.

It must be uneconomical to the dyestuffs manufacturers to have to produce the many hundreds of different types of dyewares, and that is a matter which calls for serious consideration, and I would, therefore, appeal to users to assist the makers as far as possible in this direction by reducing the types of colours they use. To my mind this matter can only be efficiently tackled when the principal dyeware manufacturers in this country are co-ordinated under one control on similar lines to that great concern, the Interessen Gemeinschaft of Germany. This will avoid waste energy in research and manufacturing, and tend to the producton of essential dyestuffs on an efficient cost basis.

Colour Users and Cost

The progress in the British dyemaking industry has not been made without considerable cost to the colour using industries, and I am glad to see that Sir Harry McGowan recognised this in his recent public announcement. It is quite true that consumers contend that they must be assured of the best quality and range of dyestuffs, that they must have access to all sources of supply, and that they must not pay prices higher than their competitors in the world markets; and these claims are not unreasonable when it is borne in mind that the colour using industries, particularly the textile trade, which is by far our leading export business, have to maintain their world supremacy in the face of keen competition. During the seven and a half years' duration of the Dyestuffs Act colour users in this country have acted in a generous spirit to the British dyeware manufacturers, and have afforded them protection of a tangible type in paying prices considerably above the world's level. This, however, they cannot always be expected to continue to do. When the colour users of this country gave their assent to the Dyestuffs Act, they were definitely assured by the Government that the onerous burden placed upon them by the Act would continue for a period of only ten years. The Act is very definite on this point; in fact, the phraseology of section V, sub-section 1, is as follows:

"The provisions of this Act shall continue in force for a period of ten years from the commencement thereof, and no longer."

A week or two ago, in reply to a question in the House of Commons, Sir Philip Cunliffe-Lister said he "could hold out no hope of repealing the Dyestuffs Act, which had been a signal success." Those of us who know most about the working of this Act are well aware that any success it has obtained is owing to the goodwill and mutual accommodation shown by the three parties concerned in its successful functioning—The Board of Trade, the dye makers and the dye users, and I am sure the President of the Board of Trade will agree with me in this statement. I do know the efforts of the colour users have been towards establishing a virile industry in Great Britain. I cannot see that colour users of this country, in fairness, can be called upon to acquiesce in an extension of a Prohibition Act for the fostering of the dye making industry; their acquiescence in this Act has already cost them millions of pounds above the general level of wholesale prices

ruling in this country and abroad. It is, therefore, imperative that the utmost use should be made of the unexpired period of the Act by the British makers to fit themselves to be in a position to meet world competition, and from what I know of the able and energetic leaders of that industry, I feel confident that they will be able to meet the situation when it arises. It seems to me, however, that as time is limited, it is opportune for the two interested parties, the dye makers and the users, to get together in a round table conference with a view of coming to an agreement as to the best method of meeting the situation. It does not seem likely to me that the Government will take any steps in this matter without a recommendation from both the makers and the users, similarly as they did when the users acquiesced in the placing of the Dyestuffs Act on the Statute Book. For consideration at such a conference, it might be useful if the Dyestuffs Industry Development Committee would review comprehensively the operation of the Dyestuffs Act since its initiation and give a report as to the progress made and their conclusions.

I should feel more confident about the future of the dyemaking industry in this country if there was a closer amalgamation between the producers, and a definite step has already been made in that direction by the Imperial Chemical Industries amalgamation of the heavy and fine chemical sections of the industry embracing two of the leading dyestuff producers. The next step, therefore, seems to me to lie on the lines I have suggested in the linking together by mutual arrangement of the other leading British dyeware manufacturers.

Prices of Dyewares

I hope I shall be forgiven for raising this perennial question of the prices of dyewares, but the matter is of such vital importance to us as colour users that that must be my reason for again stressing the need for the closest revision of the cost of production in order to bring prices down to a level more comparable with the general level of prices in the world's markets.

As you are aware, the two-times factor in operation by the Licensing Committee in the consideration of applications for licences on price grounds, by a strange coincidence, has a distinct bearing upon the general level of prices of British manufactured dyestuffs. It may be taken for granted that the general level of prices of dyestuffs in this country is about two-times pre-war as against the Board of Trade Wholesale Commodities Index Figure of 140. Coal is being sold at approximately 20 per cent. above pre-war; pig iron at pre-war price; steel at 15 per cent. above pre-war, and dyestuffs 100 per cent. above. There is therefore, considerable scope for a downward trend in the prices of colour. Progressive reductions have been made and we are not ungrateful for the efforts of the British makers in that direction; and I believe I am right in stating that since the establishment of a closer amalgamation of the chemical interests, the disparity between the general level of prices and colour prices has been decidedly narrowed, and this is undoubtedly a reflection of more economical production. I am sure that I am voicing the sentiments of the users in this country when I say that they are quite prepared to continue to give preference to the British makers and to assist them for the present by paying a slightly higher price, but that preference must not be exaggerated. The textile trade of this country, as I have already mentioned, is subjected to the severest competition in the world's markets and every item in the cost of production must be carefully scrutinised if the export trade is to be brought back to its pre-war level.

From authoritative information furnished to me, I can assure you that in certain types of colour this country is paying a much higher price than its foreign competitors. My remarks apply particularly to the newer types of fast colours. The whole trend to-day is for the use of these better types of colours and it may be interesting to the general public to learn that tinctorially these colours cost from seven to eight times more than the ordinary types. Owing to the high pre-war prices, a two-times factor operates very harshly and I would ask the British makers to take a bold step in this particular series and reduce the prices drastically in order to encourage a more extended use and to meet the prices ruling in foreign countries.

The following summary of the importations of finished coal tar dyestuffs, exclusive of alizarine and synthetic indigo, taken from the Board of Trade returns, may be interesting :—

Year	Pence Per lb.	Per cent. Increase over 1913.	Tons*	Value* £
1913	11·7	—	18,394	1,892,055
1920	79·2	577	10,397	7,552,799
1921	66·7	470	2,985	1,539,406
1922	65·8	462	2,880	1,326,174
1923	49·8	326	2,808	1,004,482
1924	58·25	398	3,557	1,339,729
1925	42·99	267	1,981	646,903
1926	47·94	310	1,892	876,529
1927	52·23	346	2,081	1,021,959

*These figures include alizarine and indigo.

It will be observed that the average price per lb. in 1927 shows an increase in comparison with the two previous years. This is undoubtedly due to the fact that this country is importing a better type of colour than was formerly the case and is not due to any increase in prices. As a matter of fact, as is well known, during the past twelve months, prices have fallen slightly. There is a world-wide trend towards the use of fast dyes and higher-priced speciality colours, and this table is undoubtedly a definite confirmation of that trend.

Whilst colour users are appreciative of the quality of the productions and service which the British dyemakers give to-day, I think it also only just that I should make special mention of the excellent technical assistance and service afforded by that great amalgamation of German dye-producing firms, the Interessen Gemeinschaft. Notwithstanding the disadvantages under which they operate owing to the Dyestuffs (Import Regulation) Act, the service they have given us has been excellent, not only in actual deliveries of colour, but in placing at our disposal the benefit of their extensive technical research. They have not competed unfairly with the British makers, nor in my opinion, have they exploited the situation with their colours. They have also been of considerable assistance to the textile trade with their many specialities. We are also appreciative of the excellent services rendered by the Swiss manufacturers.

Export of Dyes

The world capacity to produce dyes is much greater than the off-take and there is no doubt that this surplus production has tended to create very severe competition in foreign markets. Germany is still the leading exporting country, although her export trade has greatly declined since pre-war. According to the latest figures I have seen, Germany is exporting about one-third of the weight she did in 1913 at about 90 per cent. of the pre-war value. Her exports are greater than all the other countries put together.

It is gratifying to record an increase in the exports of dyestuffs from this country. The following figures furnished by the Board of Trade show the position :—

Year	Weight Cwts.	Value £
1913 ..	48,673 ..	177,246
1924 ..	104,396 ..	923,933
1925 ..	104,161 ..	847,639
1926 ..	75,727 ..	614,112
1927 ..	77,633 ..	658,464

There is a very marked increase compared with pre-war but there is yet room for much improvement. Switzerland, without the coal tar resources of this country, is second to Germany in the export of dyestuffs, exporting at least twice as much as Great Britain. It will thus be seen that this country is a long way behind these two producing countries in obtaining an adequate share of the world's markets for dyestuffs and we shall not have production in this country on an adequate and economic scale until our exports are very greatly increased.

Research Council

For several years now, I have urged still closer co-operation between universities and industry, particularly the chemical industries, and it is specially gratifying to me that under the ægis of Imperial Chemical Industries there has been established a powerful and representative Research Council for determining the lines of general industrial research. This great forward step on the part of the chemical industry is one which might be followed by other industries.

Basic Intermediates for Dyestuffs : No. XX—Carbazole and Its Derivatives

By "Consultant"

CARBAZOLE has not by any means achieved the universal importance which is associated with anthracene, the compound with which carbazole is associated in coal-tar ; there are, however, a number of dyestuffs—notably Carbazole Blue and the Hydrone Blues—which are essentially derivatives of carbazole (123) and as such their preparation depends on an adequate supply of this heterocyclic amine. Although, at the present moment, sufficient carbazole is obtainable by the normal working up of crude anthracene, it is obvious that any

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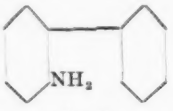

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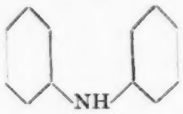

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large change-over to low-temperature carbonisation would effectually diminish this source of supply, and that the dyestuffs industry would then have to look to synthetic methods for the preparation of carbazole.

The simplest synthetic method for the synthesis of carbazole, namely, the passage of o-aminodiphenyl (124) through a series of red-hot tubes, does not readily lend itself to large-scale production on account of the difficulty of obtaining the raw material. The obvious alternative pyrogenic method of

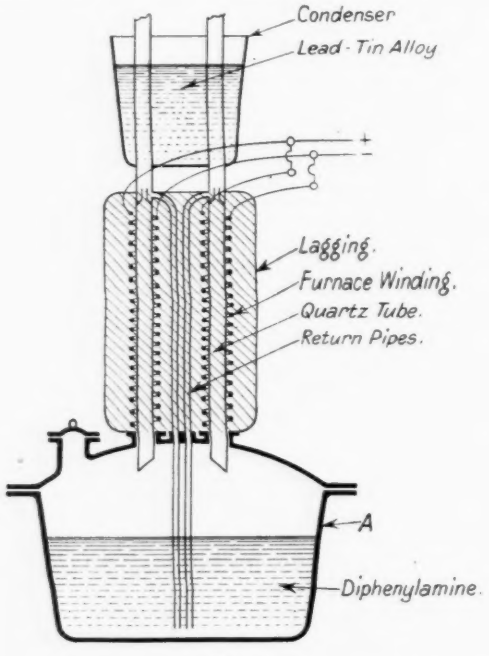


FIG. 1.

preparation, that of heating diphenylamine (125) in a similar way, is the process which is most successful on a large scale. The diphenylamine is heated in an iron vessel A (Fig. 1), to the lid of which a number of quartz tubes are attached. The lower sections of these tubes are electrically heated to bright redness, the upper sections are surrounded by an alloy of lead (7 parts) and tin (3 parts), which is just kept melted by electrical heating. The progress of the reaction is comparatively simple, the vapour of the boiling diphenylamine passing upwards through the quartz tubes in which the pyrogenic decomposition takes place and the excess of diphenylamine and its decomposition being condensed and returned to the main vessel.

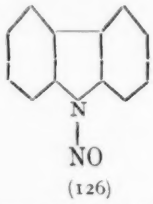
Extracting Carbazole from Crude Anthracene

The bulk of the carbazole used at the present time is prepared from crude anthracene, which contains approximately :—

	Per Cent.
Anthracene	40–45
Phenanthrene	20–25
Carbazole.....	20–25
Other Compounds	5–10

There are two main processes of purification, one through the formation of nitrosocarbazole, and the other through the potassium derivative of carbazole, which is formed by the replacement of the hydrogen of the imino group by potassium.

In the first method the crude anthracene (2 cwt.), after hot pressing and centrifuging, is stirred mechanically with light oil (6 cwt.) and sodium nitrite (30 lb.) dissolved in water (5 gall.) is added. Stirring is continued until an emulsion has been obtained, at which point 16 per cent. sulphuric acid is run in at such a rate that practically no nitrous fumes escape. Sufficient acid is used to decompose the sodium nitrite completely. Nitrosocarbazole (126) dissolves in the acqueous liquid, which is filtered off and warmed with acid, a process resulting in the formation of carbazole. This latter may be purified by sublimation, and is then approximately 98-99 per cent. pure.



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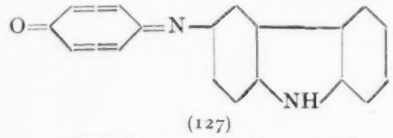
There are two noteworthy variations of the potassium-carbazole process. In the simpler method the crude anthracene is heated with an equal weight of 80 per cent. caustic potash solution and five times its weight of coal-tar naphtha at 120° C. for about five hours. The naphtha solution (which contains the anthracene and phenanthrene) is drawn off, and the residual solid potassium carbazole is decomposed with dilute acid. The filtered and dried carbazole is recrystallised from toluene or sublimed. In the second process, the crude anthracene is given a wash with hot cresol to remove impurities, and is then treated with petroleum ether to remove any remaining cresol. On extracting with crude pyridine, all the carbazole and some of the anthracene dissolve. The pyridine extract is heated with solid caustic potash in an autoclave at 220-240° C. for about an hour, after which the solid potassium carbazole is removed and treated as previously described.

Properties of Carbazole

Carbazole is a white crystalline substance, of m.p. 238 ° C. and b.p. 351° C., and it occurs in glistening leaflets which are but sparingly soluble in the majority of solvents. Carbazole itself is the direct intermediate for the preparation of two



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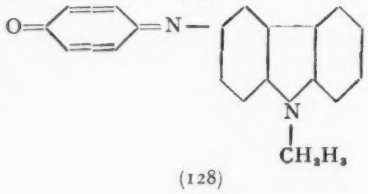

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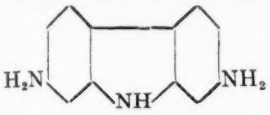
dyestuffs. The first of these, Carbazole Blue, is obtained by melting together carbazole and oxalic acid, and is, in reality, tricarbazyl carbinol. It gives a very pure blue from the hydrosulphite vat. The second dye—which is Hydrone Blue R—is obtained by the condensation of carbazole with nitrophenol and has, presumably, the constitution 127. The ethyl derivative, 128, is also produced by the indophenol condensation, but ethyl carbazole is the starting material. This latter dyestuff is known as Hydrone Blue G. In addition, it is possible to condense carbazole with various aldehydes in the presence of strong sulphuric acid in order to obtain coloured substances, but so far none of these have risen to the ranks of the more important dyestuffs. The two best known of such compounds are the condensation products of carbazole with formaldehyde, a deep green substance, and that from salicylaldehyde, an intense blue. There are two intermediates derived from carbazole which merit discussion. The first is



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3 : 6-diaminocarbazole, 129, which is a valuable substance of the benzidine type, and can be tetrazotised and coupled with various end components, as for example in Carbazole Yellow.

Its method of preparation is as follows. Carbazole (28 lb.) is dissolved in strong sulphuric acid (1½ cwt.), and rapidly stirred and cooled to 0° C., while a mixture of nitrating acids (½ cwt. of 98 per cent. sulphuric acid, 42 lb. of nitric acid) is very slowly run in. Owing to the presence of much strong sulphuric acid the NH group acts virtually as a meta directing group, and the two nitro groups enter the "3" and "6" positions. Stirring is continued for an hour after all the acid has been added, and then the reaction mixture is poured on to ice and the dinitrocarbazole which separates is washed free from acid. It is best reduced to the diamino derivative by the use of hydrosulphite and alkali. The 3 : 6-diaminocarbazole is best obtained through the hydrochloric acid salt, which is moderately soluble. 3 : 6-Diaminocarbazole is a whitish semi-crystalline powder, melting above 300° C.

The second type of intermediate referred to above is the amino disulphonic acid, 130, which may be obtained by first sulphonating carbazole to obtain the disulphonic acid and then nitrating and reducing as with the corresponding naphthylamine sulphonic acids. The details of the process resemble very closely those described under naphthylamine sulphonic acids, and need to be repeated here. The value of these aminocarbazole sulphonic acids lies in their ability to condense with tetraalkyldiaminodiphenyl carbinols with the formation of deep green dyes.

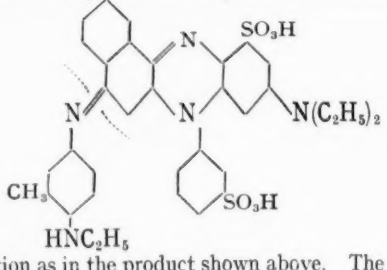
Dyes and Their Application: Recent Technical Progress

By L. J. Hooley

In the following, some of the latest developments in what are nowadays the less important series will be given. These belong principally to the basic dyes, including some acid and azo dyes derived from these by sulphonation or coupling. The points of interest in these will be found to lie in their complex structure, in the use of new intermediates, or in improvements in fastness or dyeing properties.

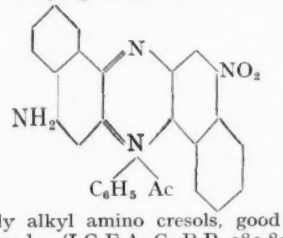
Basic Dyes

Geigy have prepared a series of green to blue acid dyestuffs, phenonaphthosafranines containing sulphonic acid groups, by condensing isorosindulines with unsymmetrical N-alkyl-p-phenylenediamines. The sulphonic acid groups may be present both in the isorosinduline and p-phenylenediamine residues before condensation, which is done in alcoholic solution. A great variety of substituted derivatives may be used in the synthesis, and sulphonation may also be carried out after



condensation as in the product shown above. The rosinduline and p-phenylene diamine constituents in the finished dye molecule are indicated by the dotted line. (B.P. 265,986, 282,805, 284,614-5, 285,486.)

Kehrmann has described the production of new azine colouring matters such as that shown. (H.C.A. 1927. 53.) By diazotising dialkyl phenosafranines and coupling with



cresols, especially alkyl amino cresols, good black copying colours are obtained. (I.G.F.A.-G. B.P. 282,804 and 283,777.)

Application of Basic Colours

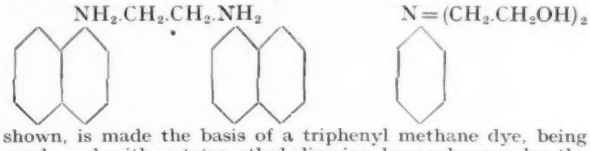
Phenols have been used in various forms in connection with the production of mordants for the fixing of basic colours. These forms, including the sulphurised phenols, which can be used as the alkali salts, as well as the recently discovered form of colloidal solutions of free phenols. Oxidation products obtained from phenols and having higher molecular weight than the original phenols may also be used for fixing basic dyes instead of tannin (I.G.F.A.-G., G.P. 432,113) both for the purposes of dyeing fabric or forming pigments.

In the production of pigments, basic dyes are precipitated with a solution of sodium silicate on to a suitable substratum such as barium sulphate or lithopone. (Dan. P. 34.077.) Some interesting data in connection with the efficacy of silica and silicates in the fixing of basic colours is also given by Michels (*Giorn. Chim. Ind. Appln.* 1927, 580). In all cases the state of subdivision or colloidal condition seems to be the determining factor, fuller's earth being more effective than any other natural silicate.

Where basic dyes are absorbed by acetyl silk the absorption is due to impurities acting as mordants.

Triphenyl Methane Dyes

Some complex constituents for the formation of triphenyl methane dyes have been used in recent dyes of this type. For example, a diaryl ethylene diamine such as the one



shown, is made the basis of a triphenyl methane dye, being condensed with a tetra ethyl diamino benzophenone by the agency of phosphoryl chloride, products containing either one or two triphenyl methane nuclei can be obtained according to the quantity of the benzophenone used. (I.G.F.A.-G., U.S.P. 1,629,884.) The products give fast violets.

A 4-alkoxy diphenylamine may be used to take the place of one phenyl group in a triaryl methane, with enhanced light fastness. In an example the 4-methoxy derivative is condensed with tetramethyldiamino benzophenone and then sulphonated to give a product dyeing in clear blue tints from a weakly acid bath (I.G.F.A.-G., B.P. 275,609).

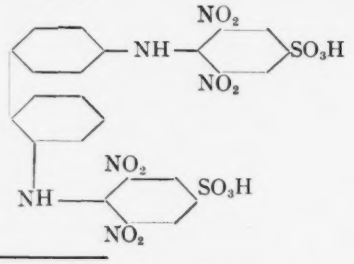
Hydroxy alkylated arylamines such as dihydroxy-diethyl aniline are used in G.P. 436,830 to obtain level dyeing soluble acid dyes, free from the defect of bronzing.

New mordant dyes can be obtained from diphenyl methane

dyes, in which there is an amino group in one phenyl nucleus and an o-hydroxy carboxylic acid grouping in the other, by coupling with naphthol sulphonic acids, these dyes being suitable for chrome printing on cotton.

Nitro Dyes

Except for a few examples which have been synthesised for acetyl silk, new examples of dyes of the nitro class are now rare. By condensing nitro derivatives of benzene and naphthalene containing reactive chlorine atoms and also sulphonic acids with diamino diphenyl or similar derivatives such as benzidine, dyes which may be used for obtaining greenish yellow to brownish red tints may be obtained. Thus from 2·4′-diamino diphenyl and 1-chlor 2·6-dinitro benzene-4-sulphonic acid a body of the constitution shown results (I.G.F.A.-G. 285,504).



Dyestuffs Markets: The Month's Business in Review

From Our Own Correspondents

Lancashire

TRADE seems to have been under the influence of the weather during June, and on the whole business in dyestuffs has been somewhat depressed. Fortunately, the dyers' strike never reached large dimensions. It is interesting to note that the institution of piece work in place of time work by one of the leading dyers many years ago brought about a strike—a direct contrast with the present position of the remaining time workers striking to be put on piece work.

As an example of the effect of a change in one industry upon another, the paper makers are experiencing really serious difficulties in the bleaching of cotton rags, owing to the rapidly increasing use of the fast vat colours in washing and light-fast fabrics. It is unlikely, of course, that the lack of means to deal with the situation will continue long, once the problem is recognised as one that has to be solved.

There are indications that dyestuff consumers are again becoming dissatisfied with the factor governing the prices of British made dyestuffs, and this in spite of the fact that a 20 per cent. reduction has been made in the last twelve months. There is little doubt that dyers are experiencing severe continental competition, but on the other hand dyers and finishers have prospered during the last few years, and it would seem on the face of it that the facts scarcely warrant a further early contribution from the less prosperous dyestuff manufacturer.

The cotton trade shows little change, and the question of organised short time is once more being balloted on by the spinners in the American section.

There is considerably less activity in the artificial silk-cotton mixture fabrics, this being the first serious check which this very promising development has experienced, and one which is probably only temporary. One notes the planned extension, costing a million and a half, to the British Celanese works, and the expansion by Courtaulds is so continuous a procedure that it no longer excites comment. Evidently no doubt exists that the saturation point is still a long way off, and equally, evidently, the British makers are maintaining their position in the share of the increasing business.

Yorkshire

JUNE was not a good month, neither for weather nor for trade, and it is said that the dyers' labour troubles are not to any appreciable extent responsible nor could the unreasonable weather have much immediate and visible effect on the consumption of dyestuffs for textiles. It is true that there were dyehouses in Bradford and Huddersfield district closed for three weeks and that in the event of continuous work more dyestuff must have been consumed, but it is argued that apart from consideration of the dispute there was scarcely sufficient work in June to keep the dyehouses running even on short time. It is not known to what to attribute the falling off. By some, the general trade depression in some of the British large industrial areas is held responsible. The corresponding month of last year was not a particularly bright one, but it was much superior to the June of this.

A note of optimism for the future, prompted probably by the receipt of a moderate number of orders, has prevailed among some of the Huddersfield worsted manufacturers. Fancy but quiet designs predominate, but plain cloths are in very good demand, comparatively speaking. In spite of the dispute it was felt that trade was improving. The woollen trade has been, and is, going through a very thin period, still regarded by some, as was said in this column last month, as bad as at any time since the slump that quickly followed the war. It is perhaps this state of affairs which gives rise to persistent rumours that the leading manufacturers, upwards of 30, contemplate a scrapping of plant and figuratively speaking, putting the rest under one administrative roof.

There has been nearly a 50 per cent. increase in the number of unemployed and short-time workers within the last month. A number of mills are working not more than two days a week. In the Heavy Woollen district the idea is gaining ground that the low class goods trade has left the district for all time. There was a time when Dewsbury was the centre to which rags from all countries were sent. A number of countries are now dealing with rags and manufacturing them into cloth.

Fashion, too, has had an adverse effect. Women wore cloth much of which was made in the Dewsbury district. Now they wear silk and artificial silk—only a very small industry as yet in that area. It is obvious that the use of smaller quantities of material in the make-up of women's clothes constitutes the more potent factor of change under the heading of "Fashion."

The registers at the employment exchanges are receiving increased numbers of names and in Ossett, out of slightly over 4,000 insured workers, nearly 2,700 are either totally unemployed or working short time. A permanent settlement of the troubles in China would doubtless lead to better conditions not only in the Heavy Woollen district, but in Bradford also. Canada still leads the way in orders from overseas.

Scotland

BUSINESS during June was fairly satisfactory in Scotland, many firms having more orders to fulfil than for some time previously. This, of course, was partly due to the desire to get orders finished before the holidays, where possible. Also, as a result of the uncertainty engendered by the dyers' dispute, there has been a tendency on the part of manufacturers to put in their orders early in order to make sure of them. Very little disturbance, however, has been caused in Scotland, and it appears now that little will be. The woollen trade in the south of Scotland is still in a satisfactory position; the majority of manufacturers, especially those engaged in the highest classes of goods, are well occupied with next season's orders. In the tweed trade, cheviots are the most satisfactory feature. Wool dyers and spinners have both a fair amount of work in hand.

Developments in artificial silk in Scotland are taking place rapidly. The conversion of the mills at Jedburgh of the North British Artificial Silk Co. is well in hand, and additional land has been acquired near the original site. During the month there was, of course, the floating of Scottish Amalgamated Silks, Ltd., with a capital of two million, and which absorbed Scottish Artificial Silk, Ltd. The presence on the board of G. S. Coats and S. V. Coats was responsible for some rumours that the well-known firm of this name were interested in the undertaking; but this was denied.

In the chemical market the demand is moderate and prices are remaining fairly steady, while in dyestuffs also there is practically no change to report.

Dyestuffs Monthly Supplement

Published in the second issue of "The Chemical Age" each month

Communications relating to editorial matter for the Dyestuffs Monthly Supplement should be addressed to the Editor, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4. Advertisement matter, subscriptions, etc., should be sent to the Manager. The Supplement is devoted to the interests of both manufacturers and users of dyestuffs, and contributions will be welcomed.

Dr. Armstrong's Resignation

THE event of the month has been the resignation of Dr. E. F. Armstrong as director of the British Dyestuffs Corporation. Very little has been said about it, because such matters do not profitably lend themselves to discussion. Dr. Armstrong's term of office has covered three years, and in that time even the merest outsider can see an enormous change in the situation. The Corporation for a long time seemed to be in a very anxious positon, and many onlookers were anxious about it too, for it represents the basis of the British dyestuffs industry. The research organisation has obviously improved, and the chemical staff have enjoyed a period of stability and comfort. As the announcements of new colours from time to time have shown, the range of production has extended, and the quality of British dyestuffs is no longer a matter of doubt. A certain amount of works concentration has taken place, and now that the Corporation is merged in Imperial Chemical Industries its future, with that of the industry generally, may be regarded as assured.

It will be a satisfaction to know that Dr. Armstrong still retains a consultative connection with Imperial Chemical Industries. His work in the field of chemical research has already brought him high recognition, and his combined knowledge of science and industry far exceeds the usual standard. The dyestuff industry, considered solely from the commercial side, may seem comparatively small, but as a school of organic chemistry, essential to the maintenance of an adequate staff of research chemists, it is of national importance, and everyone concerned in the future of British chemistry will desire to see its standing in this respect maintained. Fortunately, in the case of Imperial Chemical Industries, there is no need to emphasise the importance of research. Lord Melchett has done, perhaps, more than any single authority to press the claims of research on British industrialists, and what he commends to others there is no danger of his ignoring in the great concern he has brought into existence.

Safeguarding Policy

As one of our market correspondents points out, the prospective expiration of the Dyestuffs (Imports Regulation) Act of 1920, which was passed for ten years and "no longer," raises an issue of great practical interest to all concerned in the industry. Ten years may have seemed a considerable period for a guarantee when the Act was passed, and the assumption, clearly expressed in its terms, was that it would suffice for the establishment of a national industry. But looking back at the position then and comparing it with the changed situation to-day, can anyone seriously suggest that the progress made has not far exceeded the highest expectations? To an extent almost incredible when the Act was passed, the British industry is meeting the colour needs of this country. There is still a margin of colours for which we have to depend on outsiders, mainly Germany and Switzerland, which are able to produce them as part of their older and more complete organisation. The range of British colours, however, continues to expand, and the industry step by step is approaching a complete service.

When the time comes for deciding whether the Dyestuffs Act must end or still go on, possibly with modifications, the decision will be determined by practical common sense and not by the strict letter of the terms of eight years ago. That is why the consultation suggested by Mr. Sutcliffe Smith seems to us so necessary among the interests immediately concerned. If these come to a definite understanding as to what is fair and desirable in the interests of the colour industry as a whole, their recommendations will carry weight with any Government that may be in power and also with the public. It appears important, however, that the necessary deliberations should not be delayed too long, but that agreement should be reached in good time to be laid before the public.

Dyestuff Licences for July

THE following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during July, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee:—

The total number of applications received during the month was 703, of which 575 were from merchants or importers. To these should be added 18 cases outstanding on June 30, making a total for the month of 721. These were dealt with as follows:—Granted, 656 (of which 628 were dealt with within 7 days of receipt); referred to British makers of similar products, 53 (of which 45 were dealt with within 7 days of receipt); outstanding on July 31, 12. Of the total of 721 applications received, 673 or 93 per cent. were dealt with within 7 days of receipt.

New B.D.C. Colour

IMPERIAL CHEMICAL INDUSTRIES announce the issue of Monolite Rubine B.N. Paste, a further addition to the B.D.C. Monolite series and of particular interest to makers of printing inks on account of the dichroic character of the shades and the beautiful clean bluish undertones. Monolite Rubine B.N. Paste is a water-soluble product giving very pleasing results when precipitated as a calcium lake with calcium chloride. The barium lakes are of interest in certain cases, but they do not possess the fastness to light or the beauty of undertone that distinguish the calcium lakes.

The Dyestuff Maker's Point of View

MR. SUTCLIFFE SMITH'S pronouncement on the subject of the British Dyestuffs Industry, when making his recent address to the Colour Users' Association, was not allowed to go unchallenged by a correspondent, who, in the local Press, put forward an opinion which he said would be shared by all who, while being ardent Free Traders, are nevertheless loyal enough to desire that the new British dyestuffs industry shall prosper, especially when it has an important bearing on national security in case of war.

Certain colour users, he said, exercised efforts to secure the free import of German dyes into this country on the ground that in a short and economically difficult period of ten years or so the British manufacturers have not found it possible to supply their products at a rate similar to the foreigner. He points out that the President of the Colour Users' Association omits to mention the fact that the British manufacturer has had to build up his industry in a time of heavy taxation, high cost of labour, and competition such as the German industry never had to face in

its history of forty years or more. Whilst several commodities now being bought at a lower rate than dyes were enumerated, no comparison of dyeing prices was made, and although dyestuff prices have fallen to the extent generally of about 50 per cent. in recent years, a certain dyeing concern has found reason actually to raise its prices instead of passing the reduction on to the deserving cloth manufacturer and buyer. An explanation is called for as to how it comes about that during a very difficult period, and despite the alleged high price of dyestuffs, at least one large dyeing syndicate has been able to make extremely high profits and pay large dividends on its large share capital. The correspondent suggests that if their dyeing prices are not actually twice pre-war, they are twice what they should be, and even then they would be able to show a reasonably high profit. He thinks the colour users should reduce their own prices, and so inspire others to do the same, instead of singling out one new and struggling British industry beset on all sides by difficulties unknown in any other trade.

A Well-Earned Tribute

A PLEASANT and well-deserved compliment was paid to Scottish Dyes, Ltd., at the opening on Monday of an industrial exhibition organised in connection with Carlisle's Civic Week. Sir Frederick Chance, head of the firm of Ferguson Brothers, who for a century have been leading manufacturers in the city, referring to Carlisle's modern industrial development, said that a local firm—the well-known firm of Scottish Dyes, Ltd., founded by Mr. J. Morton—had so developed fast dyes since the war that they were now producing a full range of fast colours, formerly the monopoly of the German dye firms. Germans were now actually paying royalties on certain dyes produced at these works. The world demand for better goods and specialities was steadily on the increase, and these must be catered for. Above all, they must see their firms were efficiently represented in overseas markets.

International Dyers and Cleaners

THE International Federation of Master Dyers and Cleaners, who have just paid their first official visit to England, appear to have had a very good time and to have been impressed by the various aspects of the British industry to which they were introduced. The majority of the 75 foreign guests came from France, but there were representatives also of Switzerland, Italy, Spain, and Belgium. At a dinner to which they were entertained at the Hotel Cecil, M. Ledeuil, president of the International Federation, in responding to the toast of the Federation, proposed by Mr. F. C. Carter, thanked the English Federation for their hospitality, and said that they had been amazed at the size, modernity, and efficiency of British dyeing factories. Mr. F. J. Jackson proposed "The Worshipful Company of Dyers," which, he said, dated from the guild which was founded in 1188. They employed in the industry nearly 30,000 workpeople, and it was a tribute to their citizenship that by their careful regulation of the industry they were in the unique position in this country of having no unemployment. The Prime Warden of the Company, Lieutenant-Colonel E. T. Lea, responded.

M. du Holgouet, of the French Embassy in London, said his presence showed that the French Government took a special interest in the industry both from a national and international point of view. They in France were anxious to promote meetings between those working in the industry in both countries because only such personal contact could promote understanding and co-operation. On behalf of the French Government he had pleasure in awarding to Mr. F. C. Carter, vice-chairman of the National Federation and vice-president of the International Federation, the decoration of the Palmes Académiques for his services to the industry in both countries. M. Raine proposed the toast of the National Federation of Dyers and Cleaners, and the Chairman, responding, said that dyers all over the world were under a debt of gratitude to France, which was the first country to introduce and perfect the process of dry or spirit cleaning.

American Dyestuff Imports Increasing

IMPORTS of synthetic dyestuffs through New York and other American ports for the first six months of this year show a substantial increase over the figures for the same period of 1927. The comparative figures of qualities and invoice value are given below :—

FIRST SIX MONTHS OF 1928.

	Lbs.	Invoice value.
January	415,156	$327,148
February	478,407	391,351
March	378,191	316,183
April	633,815	505,152
May	382,233	295,969
June	411,662	309,607
Total six months ..	2,699,464	$2,145,410

FIRST SIX MONTHS OF 1927.

	Lbs.	Invoice value.
January	196,620	$186,387
February	312,277	262,364
March	404,714	352,414
April	402,783	323,732
May	349,476	265,752
June	318,450	253,054
Total six months ..	1,984,320	$1,643,703

Countries of Shipment

GERMANY, which in 1927 already commanded more than half of the dyestuff imports into the United States, has increased its percentage of the total from 56·20 to 64·21. Switzerland's trade has slightly declined, but it still retains 23·98 per cent. of the total. These two countries between them thus supply America with 88·19 per cent. of the synthetic dyes imported into the United States. Of the remainder, England supplies the small percentage of 2·26, as compared with 4·52 in the first half of 1927. The figures for the various countries are given below :—

	Jan.-June, 1928.	Jan.-June, 1927.
Germany	64·21	56·20
Switzerland	23·98	25·94
France	1·71	3·37
England	2·26	4·52
Belgium	2·96	5·43
Canada	2·29	2·54
Italy	1·93	1·88
Netherlands	0·66	0·12

Although the American dyestuffs industry has developed rapidly in the years since the Armistice, the colour users, it will be seen, still find it necessary to import considerable qualities of foreign dyes. Of these, the largest quantities are represented by the following five colours :—Rhodamine 6GDN, 6GH (single strength) 18,425 lbs., Hansa Yellow G (single strength) 16,980 lbs., Vat Brown G (single strength) 16,000 lbs., Anthra Yellow GC (single strength) 11,445 lbs., Cibanone Orange R (single strength) 11,242 lbs.

Polish Dyes Cartel

A REPORT from Warsaw states that the Polish dyestuff firms have agreed to the establishment of a cartel for the purpose of standardising products and fixing prices, with the special aim of combating German competition. In spite of their difficulties the Germans appear to be pretty active in their dyestuffs propaganda, and far from regarding it as comparatively unimportant, they still treat it as one of the most important branches of their chemical organisation.

Alizarinesulphonic Acid Ester: A Water-Soluble Alizarine Preparation

By E. Gebauer-Fulnegg and I. Eisner

The importance of developing water-soluble derivatives of vat colours can hardly be over-estimated. In the following article, recently published in "Industrial and Engineering Chemistry," an important investigation on this subject is discussed by two members of the staff of the laboratory of chemical technology of the University of Vienna.

SINCE very early times alizarine has been an important dyestuff because of the brilliant red shades of extreme fastness which it produced on textile fibres. In recent years, however, there has been a constant decrease in the use of this valuable substance, not because of its displacement by better dyes, but because of the complex process of application which involves high costs, loss of time, and uncertainty regarding the results. It seemed probable that these difficulties should be overcome and the process of dyeing simplified by altering its chief disadvantage, its insolubility in water.

Durant and Huguenin (Swiss Patent No. 102,540, 1926) were among the first to develop on a practical scale a method of converting vat colours into water-soluble derivatives by esterifying the corresponding leuco compounds with dibasic acids. The products produced in this way are hydrolysed and reoxidised on the fibre. The commercial importance of this process is limited by a number of disadvantages both in the preparation of the esters and in their use, the most troublesome operation being the control of the very sensitive leuco derivatives during esterification. It is for this reason that these derivatives of vat colours are expensive. German Patent Application No. 19,666—IV. 8m. mentions a sulphonic ester of alizarine. This type of compound has been touched upon already in a more general way in French Patent No. 557,666. It was the practical and theoretical interest inherent in such an ester that led to the present investigation.

Preparation of Alizarinemonosulphonic Acid Ester

In attempting to produce a water-soluble alizarine derivative it is not necessary to proceed to the esterification of the leuco compound as in the case of the vat colours. It is rather to be expected that at least one of the two hydroxyl groups will be capable of direct esterification. As reagent, chlorosulphonic acid in the presence of dimethylaniline or pyridine was chosen because such mixtures seemed to be of general applicability for this type of esterification and have been used for various reactions—as, for example, with *N*-acetylindoxyl, from which Schwenk and Jolles (*Biochem. Z.*, **68**, 347, 1914; **69**, 467, 1915) prepared the corresponding sulphuric acid ester. The monoacid esters thus formed are strong acids of the type $ROSO_3H$, capable of forming numerous salts.

When this reaction was applied to alizarine, a mono-sulphonic acid ester was formed, as expected, and it was found that this ester in the presence of strong alkali was divalent, giving salts of the type R-OX-OSO_3X, while with the weaker bases, pyridine or dimethylaniline, only the hydrogen of the strongly acid group was replaced by the positive radical. The neutral salts formed with strong acids were decomposed, even by acetic acid, to give monometallic salts corresponding to those obtained from organic bases. All the salts of the ester undergo hydrolysis when treated with concentrated hydrochloric acid, and the sulphonic acid radical is completely removed, the reaction being quantitative. This characteristic reaction was employed as an analytical method in order to check the sulphur value obtained by the method of Carius. The esters are remarkably stable toward alkalies.

Procedure

Twenty grams of alizarine are thoroughly mixed with 30 grams of dimethylaniline, and to this a mixture of 180 grams of dimethylaniline and 40 grams of chlorosulphonic acid, prepared by cooling with ice, is added. After standing two hours at 50° to 60° C., the reaction mass is made alkaline and the excess of dimethylaniline is removed by steam distillation. Then the uncombined alizarine is filtered off after acidifying with acetic acid. From this acid filtrate the monosodium salt of the alizarine monosulphonic acid ester can be salted out as golden yellow leaflets. If the filtrate is made alkaline, the disodium salt of the ester is precipitated with sodium chloride, and can be purified from sodium acetate by fractional crystallisation. Thus, 12 grams of the disodium salt are obtained.

The unsatisfactory yield and the difficult fractional crystallisation of this method led to the following simple procedure: Ten grams of alizarine are dissolved in 40 grams of dry pyridine, and 20 grams of chlorosulphonic acid are added with careful cooling and good mechanical stirring. After standing one-half hour the reaction mass is treated with about 70 c.c. water and the insoluble yellow crystals are filtered off. They can be used directly for the padding process. When these crystals are heated in water for any length of time, they are hydrolysed and alizarine is precipitated. This salt was therefore crystallised for the analysis from water *in vacuo*. The mother liquor was also evaporated in a vacuum and then made alkaline. Thus, on neutralisation more of this ester was obtained. The total yield was 15 grams. The pyridine employed in the reaction can be recovered.

Analysis of this material agrees well with the figures obtained for a monopyridine salt of an alizarine-monosulphonic acid ester.

0·1312 gram substance: 0·2743 gram CO_2 (0·0380 gram hydrogen)
0·1274 gram substance: 0·2665 gram CO_2 (0·0371 gram hydrogen)
0·0932 gram substance: 0·0545 gram $BaSO_4$ (method of Carius)
0·0854 gram substance: 0·0496 gram $BaSO_4$ (hydrolysis with concd. HCl)
0·1271 gram substance: 4 c.c. nitrogen (748·4 mm., 21° C.)

$C_{19}H_{13}O_7NS$. Calcd.: C 57·12, H 3·28, S 8·03, N 3·51 per cent.
Found: C 57·02, H 3·24, S 8·03, N 3·60 per cent.
C 57·05, H 3·26, S 7·98 per cent.

If the pyridine salt is treated with calcium or barium hydroxide or with the carbonates of the alkalies, the corresponding dimetal salts are obtained, which have also been analysed.

Use of Salts for Dyeing and Padding

Obviously any application of the salts of the alizarine-monosulphonic acid ester for dyeing processes would depend on a suitable method of hydrolysis. Such a method seemed to be available, because it was observed that the pyridine salt of of the ester decomposed at about 100° C. In fact, it was found impossible to recrystallise this salt from boiling water without regenerating a considerable amount of alizarine. While this interesting property showed the pyridine salt to be probably too sensitive for dyeing operations, the alkali salts showed no tendency to decompose at temperatures requisite for dyeing or padding. Oxalic acid proved to be capable of hydrolising the alkali salts of the ester under conditions which would not damage the cotton fibre. Apparently the first reaction is the formation of the free ester acid which, being very unstable in the presence of water, decomposes at once into alizarine and sulphuric acid at higher temperatures.

In applying these observations the first difficulty encountered in using the pyridine salt was its poor solubility in water. This could be offset by the use of an excess of pyridine; but even then, as was to be expected, the alizarine preparation decomposed in the boiling dye bath before it was fixed on the material, so that the colour utilisation was very poor.

On the other hand, a padding process using material prepared in the usual way with calcium and aluminium salts was successful. The first experiments (*a*) with pyridine salt, without the addition of oxalic acid on material padded with calcium and aluminium salt, were not successful because the calcium and aluminium salts of the ester were formed in the ager before the ester had hydrolysed. These salts, once produced, would not decompose at the temperature of ageing without the action of an acid. Being a dull red, they impaired the brilliance of the shade obtained. Though they could be removed by a thorough washing of the material after padding, this method was obviously not economical, since a certain percentage of the alizarine was lost as the calcium and aluminium salts of the ester removed.

This difficulty was obviated by using a process (*b*) based on hydrolysis with oxalic acid which decomposes all the salts of the ester at higher temperatures, thus allowing the use of the

very readily soluble alkali salts of the ester. This process gives a brilliant red equal to the shades obtained by the old methods of dyeing Turkey Red with alizarine, yet the whole procedure does not take more than fifteen minutes.

Procedure for Padding Process

(*a*) The material, previously treated in the usual manner with aluminium and calcium salts, was padded with 1 to 4 per cent. solution of the pyridine salt, which contained 2·5 per cent. of pyridine for each per cent. of dyestuff. The material was dried and a yellow-orange colour obtained. The alizarine red was developed by heating the material in a Mather-Platt apparatus for ten to fifteen minutes at 2 atmospheres pressure In order to obtain a brilliant and clear red, the material had to be washed very carefully with hot soapy water to remove the non-hydrolysed and insufficiently fixed calcium and aluminium salts of the alizarine ester.

(*b*) The material, impregnated with calcium and aluminium salts in the usual way, was padded with a cold solution containing 3 to 5 per cent. of the sodium or potassium salt of the alizarinemonosulphonic acid ester and an equal amount of oxalic acid. After drying, the material was treated in the Mather-Platt apparatus at 110° C. for ten to fifteen minutes with fairly dry steam. Brilliant and clear shades of alizarine red were obtained.

Action of Light on Dyed Colours

Isolation of Products Formed

In a paper published by Miss Eva Hibbert in 1927, on the isolation and identification of the products of the action of light on Indigo dyed cotton, it was proved that Indigo faded with the formation of isatin, which is produced when Indigo is attacked with oxidising agents. The result was confirmed by Haller, Hackl and Frankfurt (*Textilber*, 1928, **9**, 415), Hibbert's priority being acknowledged. Further work on the subject is published by F. Scholefield, Eva Hibbert, and C. K. Patel in the *Journal of the Society of Dyers and Colourists* for August. It is now shown that products analogous to isatin are produced by the fading of other indigoid colours dyed on cotton, and that in the case of each of the colours investigated oxidation is the cause of fading.

Fading of Ciba Blue 2B

40 g. calico, which had been dyed with 5 per cent. commercial Ciba Blue 2B in a hydrosulphite vat, and each side successively exposed to sunlight in Manchester for 2½ weeks under glass, was extracted three times with 150, 100 and 100 c.c. hot water. After concentrating the mixed aqueous extract, it was extracted three times with ether. On distilling off the ether a brownish-red substance, melting at 195°–205° C., was obtained. This was quickly washed thrice with a few drops of ether. The substance remaining melted at 210°–215° C. and weighed 0·014 g. Its aqueous and alcoholic solutions became pink on the addition of alkali. It was found to contain halogen by the copper wire test, and appeared under the microscope in the form of prismatic needles, isomorphous with isatin.

A sample of the same batch of Ciba Blue 2B was slowly oxidised with potassium permanganate in 10° Tw. sulphuric acid solution, and the oxidation product was extracted with ether. From 2 g. Ciba Blue 2B, 0·007 g. of a reddish brown substance, melting at 190°–195° C., was obtained. It gave the halogen test and pink colour with alkali, and appeared to be identical with the substance obtained from the exposed cloth. The separation was complicated by two factors: First, it was necessary to use hot water in order to extract an appreciable quantity of fading product, thus introducing a small quantity of impurity from the decomposition of the cellulose. Secondly, and of greater account in the investigation, was the fact that the commercial Ciba Blue 2B used contained lower and higher brominated Indigo products than tetrabromoindigo, its main constituent. In a further experiment, chemically pure Ciba Blue 2B (tetrabromoindigo) was dyed from a hydrosulphite vat and exposed to light for six weeks (four weeks on one side and two on the other) in Manchester under glass. It faded to a decidedly greenish shade. By extracting with water and then treating the aqueous extract with ether as previously described, 0·19 g. of a brown solid, m.p. 237°–242° C., was obtained from 150 g. calico. This was further purified to constant melting point 247°–248° C. by crystallising from 50 per cent. alcohol. The yield was 0·15 g. The m.p. of this substance was the same as that of pure dibromoisatin, and the m.p. of a mixture of the extracted product with pure dibromoisatin showed no alteration.

Another piece of calico dyed with commercial Ciba Blue 2B, and exposed to sunlight for about seven weeks, was extracted, and 0·13 g. substance, m.p. 237°–242° C., was obtained. This was crystallised twice from 50 per cent. alcohol, and was found to yield 0·11 g. of a substance melting at 247°–248° C., which was the same as that of pure dibromoisatin. By extracting 20 g. cotton dyed with commercial Ciba Blue 2B and exposed for 48 hours to ultra-violet light, impure dibromoisatin was obtained. The m.p. was in this case 232°–237° C., but the amount extracted was too small to carry the crystallisation further.

Fading of Methylindigo on Cotton

A piece of cloth dyed from a hydrosulphite vat containing 5 per cent. of Methylindigo on the weight of the cotton was exposed to light and extracted in a similar manner to that described for Ciba Blue 2B, and on distilling off the ether, 0·45 g. of a brown extract was obtained. This was washed with a few drops of ether, which removed a brown viscous substance. The residue was recrystallised from 50 per cent. alcohol until it showed constant m.p. 265°–266° C., which is the m.p. of *o*-methylisatin. From 17 g. cloth dyed with *o*-methylindigo and faded in ultra-violet light for 48 hours, 0·03 g. of a brown substance, m.p. 263°–264° C., was obtained. This gave a pink coloration with alkali and had the same crystalline form as *o*-methylisatin.

In no case has any other product than the corresponding isatin been isolated, and in view of the small weights of material available for recrystallisation the yields may be considered satisfactory in each case.

The isolation of the products of fading of indigoid colours on cotton fabrics having proved practicable, the authors are continuing the investigation with the object of the detection and isolation of the fading products of other types of colours.

The Spectrophotometer

Notes on Its Industrial Applications

A bibliography of recent work on absorption spectroscopy, selected by Dr. W. R. Brode, has been published by Adam Hilger, Ltd., 24, Rochester Place, London. It gives references to, and notes on recent papers on, the absorption spectrography of the visual, ultra-violet, and infra-red regions. Of special interest is the section dealing with the industrial uses of the spectrophotometer of the Hilger-Nutting type. It provides an accurate and rapid method of hydrogen ion concentration determination (Brode, *J.A.C.S.* 46, 581 [1924]), which can readily be applied to plant control work. In the dye industry it is particularly useful in the determination of concentration and purity, since the absorption spectrum of a dye gives a measure of its colour purity as well as its concentration. Standard curves of pure commercially important dyes have been prepared by the Dye Laboratory of the U.S. Bureau of Standards on a number of the most important dyes (Gibson *et al.*, *Sci. Papers of the Bur. Stds.* 18 [1922]; Appel, Gibson *et al.* [forthcoming paper]; Appel and Brode, *Ind. and Eng. Chem.* 16, 797 [1924]; Appel, Brode and Welch, *Ind. and Eng. Chem.* 18, 627 [1926]; Brode, *Ind. and Eng. Chem.* 18, 708 [1926]). In these papers data are given on the standard absorption curves for a number of dyes, methods for the spectrophotometric determination of the amount of dye present, detection of impurities, and in certain cases the quantitative estimation of the impurity present.

Other commercial applications include the absorption spectra of concentrated sugar solutions to determine the colour of sugar (Peters and Phelps, *Bureau of Stds. Tech. Papers* No. 338 [1927]); the study of coloured glasses, such as used in photographic filters, eye protection and the like (Gibson, *J. Opt. Soc. America*, 13, 267 [1926]; *Bur. of Stds. Sci. Papers*, 18 [1922]). Reflection spectra measurements have been applied to the study of paint samples (Gardner, *Physical and Chemical Examination of Paints, etc.* [1925], chap. iii. p. 34), paper samples, dyed fabrics and the like; to measure colour intensity, to compare samples, and obtain some quantitative data on the rate and nature of fading of exposed samples.

The above bibliography may be obtained from the publishers.

Dyeing Fast Vat Colours

By C. E. Brookes

(*From a contribution to the spring meeting of the Dyers, Bleachers, and Finishers Division of the Southern Textile Association, U.S.A.*)

THE subject assigned to me is not that of dyeing vat colours, but something rather more, that is, the dyeing of *fast* vat colours; and since this is a meeting of dyers, bleachers, and finishers let us take it for granted that we are speaking of and meaning fast to bleaching.

Dyestuff manufacturers introduced vat colours to the textile trade several years ago, and let us presume that they had one main thought in mind and that was to produce dyestuffs that would stand chlorine, whether it be chlorine in the laundry or chlorine in the bleachery, in addition to boiling soaps, sodas, etc.

In order to dye fast vat colours let us see first what we have to work with. There are three groups of vat colours, sold under many different trade names. In reality they are as follows:—

The Anthraquinone Group
The Indigoid Group
The Carbazol Group.

The above groups vary somewhat, and we also find in both practice and theory that different colours in each group and also some in the same group vary in their properties; that is, vary from a standpoint of dyeing temperature, exhaustion, level dyeing, and also fastness.

Therefore in order to dye colours that will stand bleaching and to be sure that the dyer is dyeing fast vat colours, it is absolutely imperative that the dyer should be very careful in his selection of the vat colours to be so employed, always taking into consideration the fabric to be subsequently produced and decide whether the piece goods, such as "chambrays," have merely to stand the laundry tests or whether he is dyeing yarns that have to go into piece goods such as towels, shirtings, handkerchiefs, etc., that have to stand piece bleaching.

I am somewhat afraid we have been a little too careless. Too many dyers are prone to think they are dyeing vat colours and that vat colours are *fast*. Let me tell you one and all, vat colours are only *fast* when they are dyed *fast*; is not it a fact that you know cases where the same vat colour dyed in one plant stands bleaching with no marking off or bleeding, yet that same colour dyed in another plant will not stand the same bleacher's process?

Since in all practice there is the human element involved, processes, like products, will vary somewhat; but even though both the dyer or the bleacher may vary their process from that employed by their neighbours, I contend that certain basic principles must be adhered to.

All dyers know the general and accepted process or formula for the dyeing of vat colours, and I am not here to endeavour to change the accepted methods. Rather I should feel that my time had been well spent if I could bring out the one little thought or point that might make it more easily possible to do the actual dyeing and to adhere to the regular accepted method at the same time.

We are all agreed that vat colours are dyed approximately as follows, according to formula:—

First: *Wet out* or *boil out* the raw cotton, yarns, warps, tubes, or skeins to insure proper penetration, and set the bath at the dyeing temperature with the addition of a little hydrosulphite and caustic soda. Second: Reduce the dyestuff with the necessary chemicals that the formula calls for and add same to the machine. Third: dye the usual length of time. Fourth: Wash thoroughly to eliminate any excess colour and chemicals from the fibres. Fifth: Oxidise by developing or soaping, according to the specific requirements.

Chemical Action

Theoretically, the above should give us fast dyed vat colours, and on warps where the washing action is physical and complete I do believe we are safe; but on closed type machines, such as raw stock circulating, package, or beam machines, it is well-nigh impossible to get complete washing, because the stock forms a perfect filter. Therefore, where it is impossible to get a real physical action in the washing, there is only one thing left for us to do, and that is resort to chemical action. Such chemical action, in my opinion, is attained by the addition of a sulphuric acid sour to the wash to ensure absolutely the removal or neutralisation of the caustic soda employed in the dyeing. This caustic soda must be eliminated by some method before the oxidation is attempted, and where we cannot wash it out we must kill it.

All the text books tell us that vat colours will stand almost anything in the bleaching process with the exception of a caustic soda boil. How can the bleacher, no matter what process he uses, boil without caustic soda if it is present in the yarn when he receives the goods? Bleaching of coloured striped fabrics is hard enough even when the bleacher knows what chemicals he is using, and almost impossible if the dyer ships the bleacher fabrics containing chemicals in the coloured stripes. We cannot be too careful; washing and souring cost very little. Be sure and eliminate all the caustic soda and hydrosulphite before attempting developing.

Continental Dye Cartel

A PRELIMINARY agreement is reported to have been reached between a French-German-Swiss dye cartel and the Italian dye-explosives cartel, the latter including Italgas and Montecatini, according to information received through U.S.A. Commerce Department trade representatives in Europe.

This agreement, it is said, establishes quotas on dye imports into Italy, based on 1927 totals, the quotas from the three countries being as follows: Germany, 70 per cent.; France, 20 per cent.; Switzerland, 10 per cent. It is further understood that the explosives import arrangement is almost the same as the foregoing dyestuff understanding. It is stated that the agreement is not yet signed, but it is understood to be operating tentatively.

The foregoing (in U.S. opinion) is in line with the creation of a chemical cartel covering all Europe, and is the first indication that Italian interests have joined this undertaking, which is making rapid progress and is speedily consolidating its position throughout continental Europe under the leadership of Germany.

Dispatches indicate also that Swiss and French pharmaceutical interests have entered into a general agreement which follows, as part of the general scheme of events, the original dyestuffs agreement between Germany and France.

Identification of Red Dyestuffs on Cotton

ACCORDING to the following methods given in the *Deutsche Farber Zeitung*, it is possible to identify the class of dyestuff to which a red shade belongs. The only requisites for the tests are a few test tubes, concentrated hydrochloric acid, caustic soda, a solution of stannous chloride in acetic acid, and hydrosulphite.

1. Heating a cloth sample in concentrated hydrochloric acid in a test tube.—A yellow shade turning to violet after cooling and the addition of caustic soda, shows Turkey Red.

A dark shade (mostly brown to red-brown) points to substantive or diazotized red. The following remain unaltered: Para Red, Vat Red and Naphthol AS.

2. Heating a cloth sample with stannous salt and hydrochloric acid.—Vat Red is reduced immediately (recognisable by change of colour). If reduction (decolourisation) occurs after a longer period, but before destruction of the fibre (the dyestuff outlasts the destruction of the fibre) the dyestuff is Naphthol AS.

3. Boiling a sample in water.—If the dyestuff is not fast and is stripped off, this indicates a substantive red. Diazotized red likewise bleeds on an addition of some soap, but if no dyestuff is stripped off, a hydrosulphite solution is tried.

(*a*) If reduction (change of colour) occurs and the original colour returns after rinsing and hanging in the air, the dyestuff is Vat Red.

(*b*) With reduction and no return to the original colour on exposure to air, the cloth being yellow, the dyestuff is Naphthol AS.

(*c*) With reduction, no return to the original colour on exposure, the cloth being white, the dyestuff is Para Red.

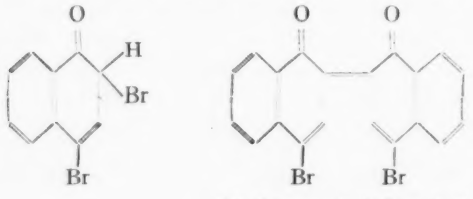
Dyes and Their Application: Recent Technical Progress

By L. J. Hooley

THE naphthols and their derivatives are readily oxidised, and the halogenated naphthols are converted to coloured products by treatment with silver oxide or lead peroxide. Willstätter and Schuler, in the February issue of the *Berichte*, give an account of the investigation of these coloured compounds, and have obtained derivatives with the properties of indigos.

Naphthalene Indigos

2:4-Dibrom-α-naphthol, on treatment with alkali or metallic copper in alcohol, or best of all by dissolving in pyridine, gives a deep blue coloured product with coppery reflection resembling indigo in appearance. The conversion is found to be due to the removal of hydrobromic acid, and not to dehydrogenation or the agency of oxygen. The constitution II given below is assigned to the substance, the compound I being probably formed intermediately. The



I

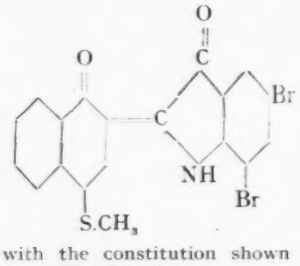
bis-Bromnaphthalene Indigo.

II

leuco derivative, dibromdinaphthol, is of course colourless, and is more stable than leuco indigo. The dyeing properties are not given in the paper.

This compound illustrates clearly the essential nature of the indigo structure as a binuclear quinone. The paper by Goldschmidt and Wessbecher which follows the above deals with related derivatives.

Mixed indigos having one half of the molecule obtained from a naphthol (phenol or anthranol) have been known for twenty years or so, having been prepared by Friedländer. As a result of the intensive work which is now being carried out in the synthesis of substituted indigos more complex derivatives of this type have been patented. In B.P. 291,825, the I.G.F.A.-G. use α-naphthols containing substituted mercapto-groups in the 4-positions, condensing these with reactive derivatives of α-isatins.



The dyestuff with the constitution shown above gives greenish-blue shades. The thioether groups may be replaced by ordinary ether groups and the isatins by naphthisatins as in B.P. 289,154 (I.G.F.A.-G.), where fast greens are obtained. Somewhat similar are the violet dyes from hydroxy tetrahydrocarbazoles.

Substituted Indigos

Among the now increasingly important substituted indigos the following additions are to be reported. In B.P. 282,805 (I.G.F.A.-G.) 2-thionaphthene-2¹-indole indigo dyes can be obtained by condensing substituted 3-oxy-thionaphthenes with 5-halogen-7-methylisatin-2¹-methyl-4¹-halogen anilides. As an example 5-chlor-7-methylisatin-2¹-methyl-4¹-anilide is used with 4-methyl-6-chlor-oxythionaphthene. In a patent of addition, 283,118, differently substituted anilides are employed.

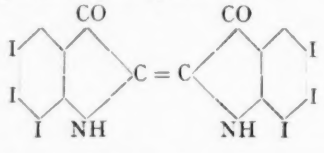
7-methylisatin with oxythionaphthenes gives yellow to brown shades (U.S.P. 1,650,139, Grasselli).

A large variety of chlor- and methyl-phenyl thioglycollic acids are used as starting points for thioindigoid dyes in B.P. 251,996, 267,177, and 271,906 (I.G.F.A.-G.).

Iodine Derivatives

While mentioning halogenated indigos it is of interest to consider the iodo-compounds. Iodine Green, the methiodide of Methyl Violet and the first synthetic green, was used commercially for a short time until replaced by Methyl Green, the corresponding chlorine body, but iodine has long been quite out of the question as an intermediate for dyestuffs except as a catalyst, being now used only for pharmaceutical products and in the photosensitising dyes where the cost is a secondary consideration. But for this, it would have been a useful element in synthesis because of the reactivity of the iodo-derivatives. The iodo-indigos are, however, of interest theoretically. Borsche, Weüssmann and Fritzsche (*Ber.*, **57**, 1770) iodinated isatin with iodine chloride, obtaining 5-iodo-isatin, and converted this to 5:5¹-diiodo-indigo. This did not differ appreciably in shade from the dibrom-compound, and, except for slightly less solubility in alkaline hydrosulphite, showed the same dyeing properties, no iodine being lost in the vatting process. Kalb and Vogel (*ibid.*, 2117) prepared 4:4¹-dichlor-5:7:5¹:7¹:tetra-iodo- and 5:6:7:5¹:6¹:7¹-hexa-iodo-indigo. These were green and only vatted with difficulty; they showed the enhanced light fastness previously observed by Kalb in the case of simpler iodo-indigos.

Considering that the latter contains 74·8 per cent. of iodine, and also the colour-conferring properties of iodine, the hexa-iodide (see formula below) shows greater resemblance to indigo than might have been expected.



Of interest in connection with general fastness properties would be the behaviour of the dyeings to such tests as kier boiling, rubbing and ironing.

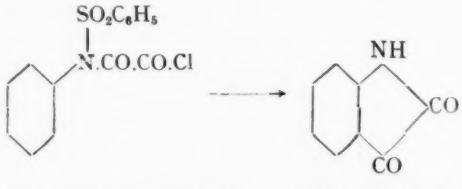
Iodine derivatives are included in the substituted oxindoles prepared in B.P. 266,539 (Schering) for pharmaceutical purposes.

Water-Soluble Isatins

Indigo syntheses from isatin chlorides or anilides with constituents containing reactive keto-methylene groups are normally carried out in organic solvents. By acting on isatin chlorides with sulphites, soluble derivatives can, however, be obtained with which the condensations can be done in water (B.P. 282,863, I.G.F.A.-G.). With concentrated mineral acids these soluble derivatives also form indigo dyes directly.

Synthesis of Isatins

A new method of making isatins consists in condensing amines with sulphonic chlorides, combining the sulphonamides with oxalyl chloride, and ring-closing the resulting oxaminic acids, afterwards removing the sulphonyl groups by hydrolysis (B.P. 265,224, I.G.F.A.-G.).

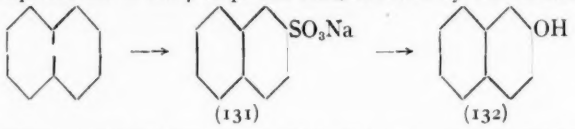


In a later patent naphthisatins are obtained by ring-closing the oxaminic acids unsubstituted by sulphonyl groups.

Basic Intermediates for Dyestuffs : No. XXI.—β-Naphthol

By "Consultant"

THERE is not the least need to stress the fundamental importance associated with the use of β-naphthol in the dyestuffs industry, since it ranks amongst the "big five" of dyestuffs intermediates. In spite, however, of the fact that there is only one basic process for its preparation, success in its manufacture can only be achieved by the closest attention to the details of the process used, especially in regard to the quality of the raw materials. The actual chemistry of the process is simple enough, and comprises the sulphonation of naphthalene to the β-sulphonic acid, followed by the caustic



(131) (132)

fusion of the sodium salt of this acid (131), during which β-naphthol (132) is formed.

Purity of Naphthalene

Naphthalene which is to constitute the raw material for the manufacture of β-naphthol should be of the highest purity obtainable, compatible with a reasonable price. It should be quite white in colour and should not have been yellowed by exposure to light or oxidation. There are several simple tests which are always applied to naphthalene intended for sulphonation. The simplest of these is the determination of the setting point, which should be between 79·5 and 80° C. The determination is best made in the Shukoff apparatus, which resembles the simple apparatus used in the "titre" tests of fats by Dalican's method. Its essential parts are a double walled flask or test-tube, the inner vessel being fitted with a rubber stopper carrying a thermometer graduated in tenths of a degree. The inner tube is filled with naphthalene, melted on the waterbath, to such a level that the bulb of the thermometer is well covered. The thermometer is read every few seconds until crystals begin to form at the bottom of the vessel. At this stage the liquid is gently stirred with the thermometer and the highest temperature to which the mercury rises is taken as the setting point of the sample.

The other most important test is that with concentrated sulphuric acid. Five c.c. of this reagent are added to three grams of the sample in a stoppered measuring cylinder, and the whole warmed on the waterbath for about half an hour, with occasional slight agitation. The acid layer should not acquire more than a rose red colour. The presence of a dark brown acid layer indicates the presence of more than mere traces of phenols and coumarone products, and also points to the fact that the sample is unfit for use in the manufacture of naphthalene-β-sulphonic acid. For convenience in the sulphonation plant it is desirable to have the naphthalene melted and cast into small lumps, rather than in the flaky crystals, which occupy much space.

Sulphonation

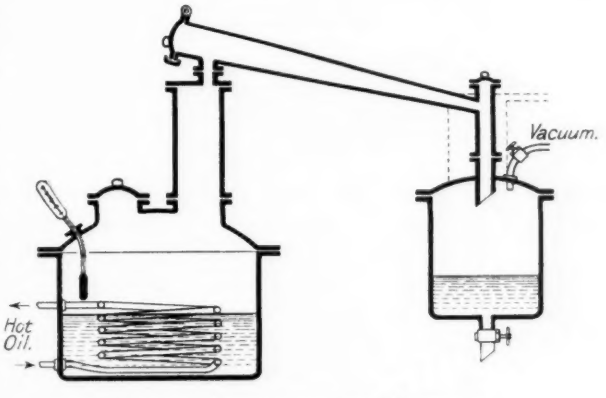
The naphthalene (2 cwt.) is melted by steam heat in a kettle placed above the level of the sulphonator, and the melted hydrocarbon is allowed to flow with vigorous stirring into sulphuric acid (2 cwt., 66° Bé.) which has previously been warmed to 100° C., and which is contained in the sulphonating kettle itself. The addition of this amount of naphthalene will take about two hours, during which the temperature will have risen to 120° C. Heat is then applied to the kettle, and in two hours the temperature is raised to 165° C., at which point it is maintained for about five hours. At the end of this period a 100 gm. sample is withdrawn and distilled in steam. The naphthalene in the distillate is rapidly filtered off and roughly weighed, and gives a measure of the amount of free naphthalene in the bulk of the batch. If the amount exceeds 5 per cent. a further heating at 165° C. is given; if not, the batch is finished off by heating for an hour at 175° C., by which time the mixture should be completely soluble in water. During the progress of the sulphonation a quantity of naphthalene (about 6-10 lb.) distils over together with water.

The method of working up the reaction mixture is the more usual one, which involves the preparation of the calcium and sodium salts. The mixture in the kettle having cooled, it is blown into water (500 gal.) and neutralised with milk of lime (a quantity corresponding to about 1 cwt. of CaO is necessary). The clear solution, after filtration from calcium sulphate, is treated with anhydrous sodium carbonate, in some factories, in order to obtain the sodium salt, the solution of which is then evaporated to crystallising point; but it is much simpler and easier to salt out the sodium salt by the addition of solid sodium chloride to the diluted liquor from the sulphonating kettle. The final sodium salt is filtered at the press and dried in vacuum ovens.

Conversion to β-Naphthol

The construction of the caustic fusion kettle is so simple as not to require repetition at this point, but it is worth while noting that very adequate provision should be made for stirring, since the sodium β-naphthoxide is immiscible with the fused sodium hydroxide and sulphite. The caustic soda (2 cwt.) is melted in the kettle with the aid of a little water (about 4 gal.), and the temperature raised to 200° C. The sodium salt of naphthalene β-sulphonic acid (2 cwt.) is then added gradually, during which time the temperature rises to 280-300° C. The fusion of this quantity requires about five hours. Several methods are available for working up the caustic melt. It may be turned out into water and sufficient hydrochloric acid added to liberate the β-naphthol without decomposing the sodium sulphite, or the sodium β-naphthoxide may be allowed to float to the top of the kettle, and removed from the lower layer of hydroxide and sulphite.

Whichever method is used the β-naphthol must be purified by vacuum distillation. The type of still used is shown diagrammatically in the figure below. The peculiar design of the still-head and receiver is to give easy access in case of



VACUUM DISTILLATION OF β-NAPHTHOL

obstruction, although in most cases obstructions can be melted away by a liberal application of steam to the outside of the still-head. The first runnings from the vacuum distillation contain water and a little naphthalene, and are discarded, whilst about 10 per cent. of the crude naphthol remains behind in the retort as a tar, which has no value. The efficiency of the vacuum distillation is, therefore, about 85 per cent.

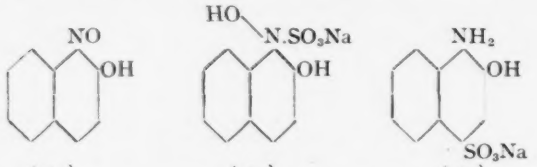
β-Naphthol may be obtained from the naphthalene sulphonic acid by several variations of the process described above, but only one of these has attained any importance—namely, the heating of sodium-β-naphthalene sulphonate (46 parts) with caustic soda (50 parts; 40 Bé.) under pressure in an autoclave for 10-20 hours at 300-330° C. It is claimed for this process that a clean product is obtained straight away, but there are obvious mechanical difficulties in the large scale application of such a method.

β-Naphthol is a white crystalline substance of m.p. 122° C. and b.p. 285° C./760 mm. As an end component, it is largely used in the manufacture of azo dyes, but its chief use is in the manufacture of various intermediates for the production of polyazo dyes. The sulphonic acids of β-naphthol have been

described in a previous article, but the manufacture of 1-amino-2-naphthol-4-sulphonic acid involves a somewhat unusual process—the formation of a nitroso naphthol.

1 : 2-Aminonaphthol-4-Sulphonic Acid

For the preparation of this compound the β-naphthol is first converted into the 1-nitroso compound (133). β-Napthol (50 lb.) is dissolved in dilute caustic soda solution (14 lb. of NaOH in 100 gal. of water). Sodium nitrite is added (25 lb., 97 per cent.) and the whole is cooled with brine coils to about —4° C. The brine coils are kept running while dilute sulphuric acid is run into the mixture (70 gal., 10p er cent.) at such a rate that the temperature does not rise above 5° C. The nitroso-β-naphthol separates out in the form of a pale green microcrystalline precipitate, which may be filtered off, washed and dried. It is important that no metal parts should come into contact with the wet nitroso compound, which is, more often than not, used directly without drying. To convert it into the aminonaphthol sulphonic acid (135), the wet paste is dissolved in cold 40 per cent. bisulphite liquor (about 4 times the weight of the dry nitroso body is used), when a light yellow solution is obtained, which is filtered from any residual tar, and warmed to 30-40° C. At this stage hydrochloric acid is added (a quantity equal in bulk to that of the bisulphite used), and on standing for twelve hours the 1 : 2-aminonaphthol-4-sulphonic acid separates out in the crystalline form. It is washed with brine and dried. The action of the bisulphite on the nitroso compound gives rise to the intermediate substance (134), from which the SO_3Na group migrates into the para position.



(133) (134) (135)

Dyestuffs Markets: The Month's Business in Review

From Our Own Correspondents

Lancashire

Dyestuffs during the month have at least held their own and in some phases business has shown a distinct gain in volume. At this period of the year such a position is very encouraging and probably means that 1928 as a whole will show a measurable improvement in the trade over 1927. Mr. Sutcliffe Smith's speech at the annual meeting of the Colour Users' Association has been the inspiration of considerable discussion in dyestuff circles, and coming, as it does from a source friendly to the makers it must be accepted as a frank statement of a point of view held by many dyestuff users. It is not to be expected that British dyestuff manufacturers agree with all the opinions expressed, as they probably consider that they have had a very poor return for the initiative and energy which they have shown; nevertheless there are some facts which will have to be faced and two of these, among others, to which Mr. Sutcliffe Smith has called attention, namely, potential excessive production and the near expiry of the Dyestuffs Act, are a formidable combination.

The position in the cotton trade shows little change. There are many schemes afoot which show promise, but it is too early to write of any success achieved. In the meantime it is rather interesting to note the swing of public opinion towards the idea of a vertical merger of all the interests which are connected with the manufacture and sale of a cotton fabric.

Theoretically, the idea appears the most obvious solution, but human nature being what it is, putting the idea into practice in any but a long drawn out series of steps seems inconceivable. The matter of new finance will present no small difficulty; present unfortunate shareholders in cotton spinning companies are undergoing a steady drain—two and a quarter millions in the first six months of 1928 and over eighteen millions in the last seven years—and under such circumstances anything connected with cotton must be very unattractive to many thousands of small capitalists.

Yorkshire

WEST RIDING industrialism is in the disturbed condition brought about by holidays or preparation for them. Leeds closed down on the 4th of this month for a week. Huddersfield does so on the 11th, Bradford on the 18th, and other colour-consuming towns and districts on various dates from now on to the middle of September. The colour manufacturer must budget for diminished turnover and curtail his works expenditure.

As was the case last month, the happiest section in the Huddersfield textiles is that specialising in medium worsteds; the market appears to be ready to receive its goods. Other sections are by no means as happy. A big falling off of demand for the finer cloths, especially for fancy weaves, has occurred. The majority of mills have had to revert to regular short time, even in the spinning departments. The repeat orders for the medium worsteds are various shades of brown rather than the bluish and silver greys expected. The woollen trade continues in a very unsatisfactory condition; a couple of days per week is the working time of some of the mills. Manufacturers express some optimism in opining that the first-class values they know they are offering will, in due course, restore a healthy demand.

Some of the factories in the Heavy Woollen District have worked overtime, but the concentrated activity was merely to complete orders for despatch before the beginning of the Dewsbury feast holidays, the volume of trade being much below that expected at this time of the year. Usually the holidays in the Heavy Woollen District are of a week's duration, but in some instances this year a longer period is being given in consequence of the scarcity of orders.

Scotland

Following the holidays the dyeing and finishing works in Scotland generally have been well occupied; in Glasgow, Paisley, Lennoxtown, and districts full time is almost general. The dry cleaners and dyers of the Edinburgh and Perth districts have also been doing very well. The Seedhill Finishing Co. of Paisley has been purchased by Wm. Hollins, and the announcement has caused some rise in share values in consequence.

The air is still not quite clear of the threat of trouble on the wages question, but in spite of some indications to the contrary there appears to be a general optimistic feeling that matters will ultimately be settled satisfactorily without any recourse to drastic measures.

Looms are still busy in the South among the tweed manufacturers. The hosiery makers are in much the same position as during the last few weeks, the number of orders being good for the time of the year. While in the tweed section the prosperity is not so great as a little time ago, practically all mills have sufficient orders in sight to provide work for some time ahead. Wools are still maintaining their prices, especially in fine yarns, and there is no immediate prospect of any drop in this direction.

Dyestuffs sales have remained steady during the month with little alteration in prices, while the Glasgow market in chemicals has remained firm.

Dyestuffs Monthly Supplement

Published in the second issue of "The Chemical Age" each month

Communications relating to editorial matter for the Dyestuffs Monthly Supplement should be addressed to the Editor, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4. Advertisement matter, subscriptions, etc., should be sent to the Manager. The Supplement is devoted to the interests of both manufacturers and users of dyestuffs, and contributions will be welcomed.

B.D.C. Direction

OUR Lancashire markets correspondent states that Mr. John Rogers, O.B.E., F.I.C., a director of Imperial Chemical Industries, is believed to be in charge of the British Dyestuffs Corporation, of which he was already a delegate director. He also holds delegate directorships of Alexander Walker and Co., Ltd., Nobel Industries, Ltd., R. and T. Jack and Co., Ltd., and the British Pluviusin Co (1920), Ltd., and is a director of the Portland Glass Co., Ltd. It is of interest that the directors of Imperial Chemical Industries hold the British Dyestuffs Corporation in such estimation as to appoint one of their own number to watch over its destinies.

End of Reparations Dyestuffs

THE obligation on Germany to supply dyestuffs on reparations account expired on August 15, and at the same time the French provision contained in the Protocol to the Franco-German trade agreement of 1927, requiring that certain dyestuffs, and chemical, pharmaceutical and other products of German manufacture over and above the quantities laid down in the Peace Treaty should be subject to import licence, also expires. As regards Great Britain, deliveries of reparation dyestuffs made under the terms of the Peace Treaty up to the end of 1925 totalled in value £112,292 11s. 9d., but since then there have been no deliveries. Deliveries were not made to a fixed quota, but were requisitioned according to requirements each year, and as for the most part they were limited to dyestuffs not made here British manufacturers were not handicapped. In the early days a much larger range was imported than latterly, as the British industry had not adjusted itself to supply a peace-time demand, but as the home range was increased so the range of the reparations deliveries decreased.

In the first half-year of 1928, German deliveries on reparations account of aniline and certain coal-tar dyestuffs, including sulphur dyes, Alizarin Red, Alizarin dyestuffs, natural and synthetic Indigo, and Indigo Carmine, to Belgium, France and Italy amounted to 16,000 double zentner, valued at nine million marks, against 9,000 d.z. (five million marks) in the corresponding period of 1927. The total exports to these countries (including free deliveries) amounted to 18,000 d.z. during the first six months of the present year, against 13,000 d.z. in the corresponding period of last year. The grand total of exports of dyes from Germany has also increased considerably. During the first half of 1928, exports of aniline dyes were 160,102 d.z (value 85·3 million marks) compared with 135,728 d.z. in the same period of the previous year. Exports of alizarin and indigo show a slight decrease because of increasing home manufacture in certain markets.

Amalgamation Rumours Denied

RUMOURS have been in circulation to the effect that negotiations wre proceeding between the Bradford Dyers' Association, Ltd., the British Cotton and Wool Dyers' Association, Ltd., and the Yorkshire Indigo, Scarlet, and Colour Dyers, Ltd. Enquiries made at the offices of the Bradford Dyers' Association, however, elicited the very plain statement that the rumours were untrue, and that the Association had not approached the others or been approached by them with regard to amalgamation. It is perhaps of some interest to glance at the positions of the companies.

The Three Companies

THE Bradford Dyers' Association, Ltd., of which Mr. G. Douglas is the chairman, was registered in 1898 to take over the business of various firms engaged in what is known as the "Bradford piece-dyeing trade." The authorised capital is £6,000,000 (increased by £500,000 preference and £500,000 ordinary in October, 1925), in shares of £1, half being 5 per cent. cumulative preference, and half ordinary, and power was taken to issue 4 per cent. debenture stock for £1,500,000. Of the preference shares £2,500,000, of the ordinary £2,170,363, and of debenture £1,453,750 have been subscribed and paid up, including 813,886 ordinary shares issued fully paid to ordinary shareholders in October, 1925 (three shares for every five held) on capitalisation of a portion of the reserve fund. The debenture stock carries 4 per cent. The dividends paid in the last few years have been as follows: 1919, 22½ per cent.; 1920, 20; 1921, 10; 1922, 35; 1923 and 1924, 25; 1925, 15 plus share bonus of 60 from reserve; 1926, 10; and 1927, 10.

The British Cotton and Wool Dyers' Association, Ltd., of which Mr. A. Hoegger is managing director, was registered in 1900 to amalgamate numerous businesses of companies and firms engaged in dyeing, bleaching, printing, and sizing cotton yarns, etc. Early in 1913, 15s. per share was written off the issued shares (the amount, £953,763, being applied in reducing goodwill account to about £40,000), and in 1919 2,000,000 additional shares were created. The authorised capital is £1,000,000 in 5s. shares, of which there is issued and paid up £774,165, including 774,164 shares each time in December, 1919 (one for two held), and May, 1923 (one for three held) by way of bonuses out of capital. There is also 4 per cent. first mortgage debenture stock for £620,000. The dividends in the last few years have been as follows: Three years to 1921-22, 10 per cent. each year; 1922-23, 10 per cent., plus cash bonus 5 and share bonus 33⅓ out of reserve; three years to 1925-26, 10 per cent.; 1926-27, 5 per cent.; 1927-28, 10 per cent.

The Yorkshire Indigo, Scarlet and Colour Dyers, Ltd., of which Mr. P. Marsden is chairman, was registered in 1899 to acquire several businesses. Capitalisation is as follows: £39,000 in ordinary shares of 5s. fully paid, ranking *pari passu* with preference in surplus profits after payment of 5 per cent. per annum on latter; £78,000 in 5 per cent. cumulative preference shares of 10s. fully paid, having participation rights with ordinary as above (authorised £80,000); and £101,615 in 4½ per cent. first mortgage debenture stock, outstanding amount of £156,000 (authorised £200,000). The dividends in the last few years have been as follows: 1919, 10 per cent. plus bonus of 10 per cent. on preference and ordinary; 1920, 10, plus bonus of 5; 1921, 5; 1922 and 1923, 7½; 1924, 5; 1925, preference only; 1926, preference only; 1927, 5 on preference, 2½ on ordinary.

The Brotherton Jubilee

ON September 1, Colonel Sir Edward Allen Brotherton celebrated the fiftieth anniversary of his foundation of the firm of Brotherton and Co. Originally founded as an

ammonia distillation works at Wakefield, the firm has increased its activities, and now includes dyestuffs and intermediates among the vast range of its products. The founder of the firm, who is also its chairman, has achieved fame not only by his remarkable industrial career, but also by reason of his great public spirit. He has touched and enriched almost every phase of civic and national life, and has been a generous donor to numerous deserving causes. The University of Leeds in particular has reason to be grateful to him, having received from him altogether about £120,000 for various purposes.

Homely Tests for Dyed Fabrics

At the Summer School of the Drapers' Chamber of Trade held recently at Cambridge, Mr. J. G. Williams, of the analytical and testing laboratory of Selfridge and Co., Ltd., dealt with various aspects of dyed fabrics as affecting stores and customers. He pointed out that although sunlight might be good for delicate babies, it was anything but good for delicate frocks made of weighted silk or coloured with inferior dyes, for their treatment under an artificial sunlight lamp soon revealed secrets which were never intended to come into the daylight. He advocated testing laboratories for all big stores. There were a very large number of chemically different dyes, yet colour fastness was a serious cause of complaint. Out of 120 samples which he tested, only 21 were found of good all-round fastness.

As a practical homely test to discover whether or not a dye was reasonably fast, he suggested that people when buying coloured material should (1) rub the material with a dry white handkerchief to ascertain if the colour withstood friction, and (2) moisten their handkerchiefs and then rub the material to see if the same dye withstood moisture. He agreed, however, that a number of women shoppers applying these tests simultaneously might cause a sensation in a shop, and that it would be safer to carry out the tests round the corner.

Loose dyes not only damaged the reputation of the dyer and the store, but might cause serious trouble to the clothes, skin, and even health of the customer. He had had an instance brought to his notice in which an 18-guinea gown had been ruined through contact with a serge tablecloth. In another case, a woman, through a faultily dyed dress, had her neck and arms turned a deep blue colour, which no amount of washing would relieve until it wore off.

American Views

It is remarkable that many American writers are unable to rid themselves of a fear that there is something sinister in the activities of I.C.I. For example, an editorial article in the *American Dyestuffs Reporter* makes a bitter attack on the United States interests which were concerned in the recent formation of the Finance Company of Great Britain and America. The article commences with an account of the efficient manner in which European industries have been reorganised. For example, in regard to the absorption of the British Dyestuffs Corporation in Imperial Chemical Industries, it says :—" Once upon a time we thought that the British dye industry was headed for certain destruction on the treacherous rocks of an agreement with the German trust—proposed but never signed. The creation of Imperial Chemical Industries removed the need for that. Now the dye industry is not on the rocks, but is standing on a rock—the rock of ample capital and sound management. Britain's output of coal-tar dyes swells from year to year. Thirty million odd pounds in 1926 ; 39,500,000 pounds in 1927 ; vat dye production jumping 41 per cent. in one year ; the output of sulphur colours boosted 53 per cent. in that same year ; all other classes of dyes produced in larger quantities.

" What can England do with the surplus that must come from such expansion ? The answer lies in more efficient production, in more extensive marketing operations abroad, in agreements with foreign competitors. Losses in one field must be recouped in other fields, new and valuable products developed and supplied to consumers in the world's markets. Profitable relations must be maintained with either European or American financial and industrial interests."

The Finance Company

The American writer then goes on, in his description of the Finance Company of Great Britain and America (" with Sir Alfred comfortably settled in the chair of the directing board "), to speak of " an enormous reservoir of American capital drawn upon to feed the development schemes of a strong British chemical trust.

" In this age of national cartels and mergers nothing has perplexed economists more than the way so many American banking firms work against the best interests of home industries. What motive acts so strongly to persuade the financial power of Wall Street to strike backhanded blows at one of this nation's most vital industries by their liberal loans to foreign competitors ? Are American millions in so little demand in America ? We concur fully in all that has been spoken on various occasions by well-meaning peace delegates ; we respect the sacredness of amicable relations between the United States and the British Empire. But we will probably be branded as demagogues because of our protest against the shortsighted policy of our international financiers in supporting the research plans of foreign interests so formidable as the I.C.I."

Dyestuff Licences

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during August has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee. The total number of applications received during the month was 529, of which 429 were from merchants or importers. To these should be added 12 cases outstanding on July 31, making a total for the month of 541. These were dealt with as follows :—Granted, 483 (of which 471 were dealt with within 7 days of receipt) ; referred to British makers of similar products, 36 (of which 22 were dealt with within 7 days of receipt) ; outstanding on August 31, 22. Of the total of 541 applications received, 493 or 91 per cent. were dealt with within 7 days of receipt.

An American Dyestuff Symposium

Included in the programme of the seventy-sixth meeting of the American Chemical Society, which takes place at Swampscott, Massachusetts, in the period September 10-14, is a meeting of the Division of Dye Chemistry. The attention which is being paid to colour measurement is exemplified by the fact that at the first session of the division's meeting six out of seven papers down for presentation deal with the subject from various points of view, and five of these are concerned with spectrophotometry. R. W. French is contributing two papers, dealing respectively with " The Spectrophotometric Determination of Dyestuffs," and " An Improved Spectrophotometer." The second session of the meeting will be concerned with papers on the preparation of various dyes and intermediates. In the third and final session more general topics receive attention, such as " Hydrogen-Ion Control in the Textile Industry " (C. E. Mullin) ; " The Dyeing of Rayon and the Capillarity Test " (A. A. Claflin) ; " A Machine for Laboratory Washing Tests," by W. D. Appel, W. C. Smith, and H. Christison, and various other subjects.

The Determination of Colour by Titanium Chloride

Advantage of Using Buffers

The method of Knecht and Hibbert for evaluating colour in azo dyes is discussed by O. L. Evenson and D. T. McCutcheon (of the Colour Certification Laboratory of the Food, Drug, and Insecticide Administration of the U.S. Department of Agriculture) in an article in "Industrial and Engineering Chemistry." In this, modifications in the method are described, together with their application to the estimation of Amaranth, Ponceau 3R and Orange I.

THE original method for the evaluation of colour in azo dyes by means of titanium trichloride was formulated by Knecht and Hibbert. The hot-water solution of the dye was reduced in the presence of hydrochloric acid, Rochelle salts, or sodium bitartrate, in an atmosphere of carbon dioxide.

For some time the Colour Certification Laboratory of the U.S. Department of Agriculture has carried out the titration of Amaranth (Colour Index 184) in the presence of hydrochloric acid. This method was found objectionable, however, for three reasons: (1) The end point is not sharp; (2) results tend to be slightly low, owing, in small part at least, to fading of the dye in acid solution; (3) it does not permit accurate or convenient evaluation of total colours in mixtures of Amaranth, with other dyes which cannot, or can only with difficulty, be titrated in acid solution. In an attempt to obviate the necessity of using acid, the titration of Amaranth in the presence of various buffers (or catalyst-buffers) was investigated. On obtaining good results in these determinations, the experiments were extended to other dyes.

Materials

Commercial samples of dye of certified grade were used, the analysis being made according to the methods prescribed for colour certification. The following salts were tried as buffers: Rochelle salt, sodium bitartrate, calcium carbonate, sodium acetate, sodium tartrate, sodium citrate, potassium antimony tartrate, and sodium bicarbonate. These were of commercial C. P. grade as obtained from several sources. The 0·1 *N* titanium trichloride used was standardised with a ferric sulphate solution made from pure ingot iron. This result was checked by standardisation against sodium oxalate. The titanium solution was 1·4 *N* with respect to the hydrochloric acid present.

Procedure

The buffer salt, in the quantity to be used, was dissolved in water by heating to boiling in a wide-mouth Erlenmeyer flask. The dye solution was then added and the contents of the flask again brought to boiling. The total volume in the flask was in all cases 100 c.c. when titration was begun. While the titration mixture was kept in an atmosphere of carbon dioxide, the reducing solution was introduced at such speed as it reacted with the dye until near the end, then drop by drop to end point. During the addition of the titanium trichloride the flask was continuously shaken.

Results

Before any value can be placed on the results of a volumetric determination for colour, they must be consistent for varying concentrations of dye in the flask and for different quantities of buffer; they must also agree closely with the "colour by difference" wherever complete analysis can be made.

The titration values for Amaranth when determined in the presence of Rochelle salts sodium bitartrate, or sodium tartrate were very erratic (Table I.) The results obtained using calcium carbonate or sodium acetate as the buffer were not consistent for the two dye concentrations. The results using sodium citrate, potassium antimony tartrate, or sodium bicarbonate were consistent and accurate for any dye concentration used in flask. The end point in each case is very sharp.

Table I.—$TiCl_3$ Consumption of Amaranth when Different Buffers Are Used

Buffer.	Buffer. G.	Dye. G.	$TiCl_3$ Consumed. No. 1 Cc.	No. 2 Cc.	No. 3. Cc.	No. 4 Cc.	No. 5 Cc.
Rochelle salt ..	5	0·1	5·98	5·93	—	6·1	5·95
		0·3	17·05	17·08	17·2	16·85	17·15
	10	0·3	17·52	17·7	17·62	17·60	17·65
Sodium bitartrate	5	0·3	16·75	16·95	16·45	16·9	16·5
	10	0·3	16·4	16·6	16·6	17·1	17·0
Sodium tartrate ..	5	0·3	17·1	17·28	17·0	16·8	—
	10	0·3	17·70	17·50	17·6	17·5	—
Calcium carbonate	5	0·1	6·08	6·08	6·2	6·2	6·3
		0·3	17·8	17·83	17·75	17·75	17·75
	10	0·3	17·8	17·8	17·8	17·85	17·8
Sodium acetate ..	5	0·1	5·95	6·05	6·1	6·1	6·2
		0·3	17·8	17·9	17·9	17·95	17·85
	10	0·3	17·95	18·05	17·9	17·9	17·9
Sodium bicarbonate	5	0·1	5·99	6·04	5·95	—	—
		0·3	17·80	17·65	17·77	—	—
	10	0·3	17·75	17·7	—	—	—
Sodium citrate ..	5	0·1	5·98	5·92	5·92	5·92	5·98
		0·3	17·73	17·75	17·78	17·73	17·73
	10	0·3	17·75	17·73	17·78	17·73	17·75
Potassium antimony tartrate	5	0·1	5·93	5·93	5·88	5·93	5·88
		0·3	17·73	17·7	17·73	17·7	17·75
	10	0·3	17·73	17·73	17·7	17·7	17·72

The values obtained for Ponceau 3R (Colour Index 80) when titration was carried out in the presence of sodium tartrate, Rochelle salts, or sodium bitartrate were very erratic. When potassium antimony tartrate was used, a sharp end point was not obtained. In the presence of sodium citrate or sodium bicarbonate the results of titration checked closely the theoretical and were consistent under varying conditions. Titration of Orange I (Colour Index 150) gave good results in the presence of all the buffers tried, except potassium antimony tartrate, calcium carbonate and sodium acetate.

The complete analyses of samples of these dyes are shown in Table II. The "colour by difference" agrees very closely with that obtained by titration in the presence of the buffer salts indicated. Crocein Orange (C. I. 26), Orange G (C. I. 27), Ponceau 2G (C. I. 28), Scarlet GR (C. I. 78), and Ponceau 2R (C. I. 79) gave low results with sodium bitartrate. New Coccin (C. I. 185), which is isomeric with Amaranth, does not give low results with this buffer, it being possible to titrate this dye accurately in the presence of sodium bitartrate.

Determination of Possible Errors

To determine the necessity for making a correction for titanous chloride consumed by the buffer, sodium citrate or sodium bicarbonate in different quantities was added to a standard solution of ferric sulphate. No increase in the quantity of reducing solutions required was detected. In another series of determinations 1 mg. of Orange I was titrated with 0.01 *N* titanium trichloride, using different quantities of a salt. The results thus obtained for sodium citrate are given in Table III. One milligram of Orange I theoretically requires for reduction 1.14 cc. of 0·01 N titanium trichloride.

Table II.—Complete Analysis of Amaranth, Ponceau 3R, and Orange I.

Dye.	Moisture.	Sodium Chloride.	Sodium Sulphate.	Water-Insoluble.	Ether Extract.	Colour by Difference..	Colour by Titration in Presence of: Sodium citrate.	Sodium bicarbonate.	Potassium antimony tartrate.	Sodium bitartrate.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Amaranth ..	7·90	2·40	—	0·08	0·05	89·57	89·20	89·30	89·10	—
	9·00	2·42	0·27	0·50	0·20	87·61	86·60	86·70	86·40	—
	9·55	3·34	—	0·07	0·11	86·93	86·90	86·76	—	—
Ponceau 3R ..	8·45	4·14	0·35	0·25	0·12	86·69	85·40	85·50	—	—
	5·72	4·70	0·31	0·12	0·20	88·95	87·87	87·75	—	—
Orange I ..	7·30	3·86	—	0·14	0·07	88·63	87·50	87·30	—	87·28
	3·20	1·74	—	0·16	0·07	94·83	93·68	93·47	—	93·68

When the volume of solution in the flask was 100 cc., however, the quantity used averaged 0.43 c.c. higher. This error is attributed to the dilution and would be negligible when 0·1 *N* reducing solution is used.

Table III—Tests for Blank on Sodium Citrate

Sodium Citrate	$TiCl_3$ (0·01 *N*) per 1 mg. Orange I					Concd. HCl per 20 c.c. 0·1 *N* $Fe_2(SO_4)_3$	$TiCl_3$ per 20 cc. 0·1 *N* $Fe_2(SO_4)_3$
	No. 1	No. 2	No. 3	No. 4	No. 5		
G./100 cc.	Cc.	Cc.	Cc.	Cc.	Cc.	Cc.	Cc.
2	1·35	1·30	1·65	1·80	1·80	—	20·15
10	1·55	1·95	1·50	1·35	1·40	10	20.12
20	1·55	1·55	1·75	1·80	2·10	20	20·15
—	—	—	—	—	—	1	20·15

Conclusion

The colour content of Amaranth may be determined by titration with titanium trichloride in the presence of sodium citrate, sodium bicarbonate, or potassium antimony tartrate. That of Ponceau 3R may be determined by titration with titanium trichloride in the presence of sodium citrate or sodium bicarbonate. Orange I may be titrated in the presence of sodium citrate, sodium bicarbonate or the tartrates, except potassium antimony tartrate. The correct buffer salt must be determined for each dye.

The results reported here and those of other investigations (unpublished) warrant the conclusion that, for the correct evaluation of the colour content of any dye, the buffer used must be tried thoroughly under a great variety of conditions before any reliance can be placed upon it. This may be due to the nature of the dye, but no attempt has been made by the writers to determine it. However, if the correct salt to use is known, the dye content can be accurately determined.

Italian Dyestuff Production

Leading Companies and Their Manufactures

THE Italian dyestuffs industry has made great forward strides since 1914, and is now able not only to supply domestic needs of the more common dyes, but to provide a considerable surplus for export. There are a number of factories making their own intermediates. Among the more important manufacturers are A. E. Bianchi and Co., with a daily output of about 5 metric tons of dyestuffs; the Italica, which manufactures excellent chrome and acid dyes, direct cotton dyes, basic dyes, and a complete line of sulphur dyes. This company now employs twenty-eight chemists, compared with four in 1914.

Another important manufacturer is the Materie Coloranti Bonelli, of Cesano Maderno, which not only manufactures dyestuffs and intermediates, but also operates an electrolysis plant for the production of electrolytic caustic soda from which 3,000 cubic metres of hydrogen are obtained as a by-product in twenty-four hours. The electrolytic hydrogen is used on recently-developed important manufacturing processes in connection with the preparation of benzidine, para-aminophenol, alpha-naphthylamine, para- and meta-phenylene and toluylenediamine, H acid, French, Cleve, and Laurent acids, and peri- and amino-salicylic acid. Likewise the problem of the transformation of nitrobenzene into hydro-azobenzene, without the aid of zinc or iron powder, has been solved by the use of the sodium amalgam prepared directly from the electrolysis of sodium chloride. In June, 1923, the Cesano Maderno plant alone was turning out about one ton of benzidine a day. At that time, however, the synthetic indigo and the anthraquinone dyes were not being made. The Cesano Maderno plants of the Nobelli now have an annual capacity of over 1,500,000 tons of synthetic indigo.

The Industria Chimica at Melagnano is a comparatively new concern which has attracted attention both at home and abroad for its chrome dye production. Italian dye manufacturers are manufacturing not only sulphur dyes, but have been successful with a number of acid dyes, among which may be mentioned the Light Yellow, Acid Red and Black, and Tartrazine. Basic and direct dyes are also made, and most important of all is the progress made in the preparation of yellow, brown, and black chrome dyes. An outstanding example of the direct dyes is Diamond Black P. V.

The Fabbrica Lombarda A. E. Bianchi, the Inca, and the Ledoga have also given special attention to the manufacture of chrome, aniline, and sulphur dyes. In Piedmont the Fabbrica Boletti and Co. was one of the first to produce sulphur dyes and lakes during the war. In 1919 this company combined with the Swiss Rohner. In this same district the Schiapparelli is producing aniline oil and sulphur dyes, and the Industria Piemontese aniline dyes.

Special mention must be made of the S. I. P. E. Cengio, in Liguria. This concern, which also controls a large number of gas plants distilling about 600,000 tons of coal annually, produces in twenty-four hours 8,000 kilos of aniline oil, 2,000 kilos of H acid, 800 kilos of para-nitroaniline, alpha-naphthylamine, etc. It also manufactures numerous nitro and chloro derivatives of benzene, toluene, naphthalene, phenol, and aniline, and other important products used in the preparation of synthetic dyes, medicines, and explosives. The company also has a plant for the production of several tons of oleum daily. It also produces daily 2,000 kilos of 85 to 90 per cent. formic acid, 4,000 kilos of caustic soda, 3,500 kilos of chlorine, and 4,000 kilos of 100 per cent. sodium sulphide. The S. I. P. E. Cengio, the Bonelli, the Italica, and the Schiapparelli merged last year.

Synthetic Indigo is produced in Italy by one company only, the Fabbriche Italiane per Materie Coloranti Bonelli, a member of the group which includes the S. I. P. E. Cengio, the Italica, and the Schiapparelli, all of which are more or less controlled by the Societa Italiana del Gas di Torino. The Italian plant is located at Cesano Maderno and has a yearly capacity of 1,500,000 kilos of Indigo in paste at 20 per cent.

Dyeing Artificial Silk Fabrics

American Technique for Fine Denier Material

A METHOD of dyeing fine denier artificial silk woven fabrics has recently been discussed by Mr. B. L. Hathorne, of the Tubize Artificial Silk Co., of America. He points out that the fine denier artificial silk fabrics are handled at present on jigs, pads and on the open kettle. As all dyers who have handled these fabrics know, it is a case of trying to choose the least of three evils. One may have trouble from streaky goods, creased goods or frayed goods, according to the machine one prefers to use. The jig, especially ball-bearing jigs, has been widely used for this type of work. Unquestionably, from a mechanical viewpoint, the jig is to be preferred, as one avoids creases and fraying and is subject only to occasional broken cut. Unfortunately, however, even on the best ball-bearing jigs, the warp is subject to tension, which is one of the major causes of warp streaks. Then again, the actual effective dyeing temperature of the jig is always below 200° F.

The padder is perhaps the least of the three evils, as it dyes so rapidly that the warp streaks are largely avoided. It is to be regretted that the pads now in use were mostly designed for heavier fabrics and have the undesirable property of fraying some voile constructions. Another undesirable feature is the effective dyeing temperature, which rarely can be made to exceed 180° F. Then again, it is obvious that crêpe constructions cannot be handled on a pad. The open kettle, though sometimes used, is a bad actor. Tangles, unavoidable on an open kettle, invariably mean torn goods when extra sheer artificial silks are handled. Perhaps even more serious are the creases from the reel.

The above-mentioned troubles—bad enough in the ordinary 75 denier qualities—are becoming still more serious, due to the growth and popularity of the recent 50 and 35 denier sheer fabric manufactured from tubize artificial silk.

Drum Machine

It is the opinion and experience of Mr. Hathorne that the ideal machine to piece dye all artificial silk voiles and crêpes is the recent drum type of hosiery dyeing machine. These sheer fabrics are so light that a surprising amount of fabric can be put into each pocket. The goods can then be scoured and dyed without danger of tears, fraying or kettle creases. The fabric can be scoured and dyed in the same machine without loss of time, which is always an advantage. There is absolutely no tension on the warp, which means much less tendency toward warp streaks. Best of all, however, is the dyeing temperature, which can be easily held between 200° and 205° F. When the drum type of hosiery machine is used, when dyestuffs are carefully and correctly chosen, and when the dye is run at as high a temperature as is possible and in the absence of, or with the minimum amount of Glaubers salt added at the boil, good results are obtained.

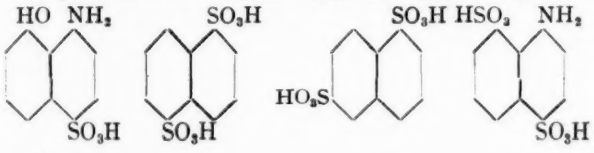
Basic Intermediates for Dyestuffs: No. XXII—Some Intermediates for the Sulphon Blue Series

By "Consultant"

In dealing with the intermediates associated with the Sulphon Blue, Chicago Blue, Naphthol Blue-black, etc. series of dyestuffs, it is, in many cases, almost impossible to separate the preparation of the dyestuff itself from the manufacture of its intermediates, and for this reason the actual preparation of some of these dyestuffs has been incorporated in the description of the intermediates of this series.

1 : 8-Aminonaphthol-4-Sulphonic Acid

This acid, often called Chicago Blue Mono S acid (136), is prepared through several naphthalene sulphonic acids which have not hitherto been described in this series. Naphthalene itself is sulphonated to the disulphonic acid stage, in which the main products are naphthalene 1 : 5-disulphonic acid and the corresponding 1 : 6 compound (137 and 138). In practice



(136) (137) (138) (139)

these two compounds are not separated but nitrated, with the result that four nitro compounds are obtained, the 1-nitro-4 : 8-disulphonic acid, the 1-nitro-3 : 8-disulphonic acid and the corresponding 2-nitro compounds; among these the first-mentioned compound predominates. These are reduced to their corresponding amino compounds (of which 139 is the most important), separated, and the 1 : 4 : 8-compound subjected to a partial alkali fusion, in which the 8-sulphonic acid group, being the more labile, is replaced by a hydroxyl group.

Details of the Process

The details of the above process are along the following lines: The first process, the sulphonation of naphthalene, is conducted in the usual type of resistant iron sulphonating kettle, provided with cooling coils and powerful mechanical stirring gear. The sulphuric acid (4 cwt.; the mono-hydrate) is run in, and the naphthalene (2 cwt.), finely pulverised, added in batches. The temperature is not allowed to rise above 30° C., so that in summer, brine coils running at −10° C. are necessary. As is usual, samples are from time to time withdrawn and tested for the presence of unchanged naphthalene by dilution with water. At the end of about 10-12 hours the sample gives a clear solution on dilution, and the sulphonation is adjudged to be complete, at least, as far as monosulphonation is concerned, for the second SO_3H group has yet to be introduced. With this purpose in view, oleum is run in (6 cwt.; 40 per cent. of SO_3), again at such a rate that the temperature does not exceed 30° C.

Disulphonation is usually complete after a further period of 10-12 hours, when the mixture of disulphonic acids and excess sulphuric acid is run directly to the nitrator. This plant resembles closely the nitrator described in connection with xylidine (see The Chemical Age, March 10, 1928, Dyestuff Suppt., p. 21), with the exception that more vigorous stirring gear of the paddle and baffle type is used. Sufficient water is added to convert the oleum remaining into the monohydrate (10 gallons), but the addition is effected gradually so that the temperature is maintained below 30° C., whilst; in addition, this temperature is not exceeded during the nitration process. Nitration is effected by the gradual addition of nitric acid of 1·45 gravity (10 gallons) over a period of several hours, and the stirring is continued for several hours after the addition of acid has been completed, the whole occupying 8-10 hours.

The neutralisation of the nitrated acids must be performed with considerable attention to detail, as far as concerns the reaction of the liquid. The reaction mixture is run out into wash water from a previous batch (200 gallons), and soda ash (1⅞ cwt.) is added fairly rapidly so that the temperature rises to about 80° C. If the temperature does not reach this point a little live steam is used to bring it up. Milk of lime is then added until Congo-paper just turns blue (about 6 cwt.) and the process is finished off with a little chalk sludge. The calcium sulphate is pressed off hot, and washed with hot water until the combined filtrate and washings total 800 gallons. Further washing gives a dilute liquor which is piped back to the neutralisation vat for treatment of the next charge.

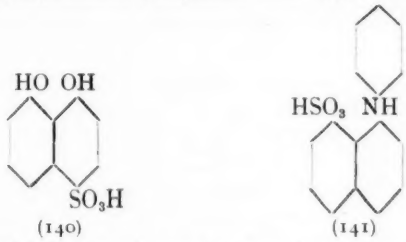
Reduction of Nitro Compounds

The reduction to the amino body requires but little description. The solution of the nitro-sulphonic acid is made acid with sulphuric acid (½ cwt., s.g. 1·4) and reduction performed by the gradual addition of iron "pin-dust" (7 cwt.). Gentle ebullition takes place during both addition and reduction, and after 5 hours the process is complete. In order to test the progress of the reaction a few drops of the liquid are spotted out on to filter paper. When reduction is complete the iron sludge leaves a brown spot with a clean white surround. If any unchanged nitro compound is present the surround is yellow in colour. The processes which follow are calculated not only to isolate the desired 1-amino-4 : 8-naphthalene disulphonic acid, but also to separate it, as far as possible, from its isomers. Milk of lime is added until the *p*H of the clear solution is 6·5, at which point soda ash is added until a test portion of the filtered liquor just gives no precipitate on the further addition of soda (about 1 cwt.).

The iron sludge is removed by filtration at the press, well washed with water, and the combined filtrate and washings evaporated to 135 gallons in a vacuum still. The evaporated solution is cooled to 20° C., at which point the bulk of the 1-naphthylamine-4 : 8-disulphonic acid separates as the sodium salt. The solid is pressed off, the residue evaporated again three times, and the several crops of the 1 : 4 : 8-acid united. The final mother liquor contains the 1-aminonaphthalene-3 : 8-disulphonic acid, and is stored until about twenty batches have been accumulated, when it is acidified with hydrochloric acid. The crude 1 : 3 : 8-acid which is thereby precipitated is filtered off, dissolved in a little soda solution and boiled for an hour with decolourising carbon. The clear filtered liquid is again treated with hydrochloric acid, and the pure 1 : 3 : 8-acid filtered off after 12 hours. The yield is about 70-75 lb. of the pure 1 : 4 : 8-acid and 16-18 lb. of the 1 : 3 : 8-isomer for each 100 lb. of naphthalene.

Chicago Blue Mono S Acid

The 1 : 4 : 8-acid is converted into Chicago acid by alkali fusion. A quantity of the well-pressed paste (corresponding to ¼ cwt. of actual acid, calculated on the nitrite titration of the paste) is added to ten times its weight of 50 per cent. sodium hydrate solution, to which technical (85 per cent.) potash (1¼ cwt.) has been added. This mixture is heated in an autoclave at 200° C. for about eight hours. The pressure rises to 7 atm., and particular care must be taken that neither this temperature nor pressure is exceeded, since too rigorous fusion results in much of the desired product passing into 1 : 8-di-hydroxynaphthalene-4-sulphonic acid (140). This com-



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pound, which finds employment as an end component in disazo dyes, is always formed to the extent of about 20 per cent. of the theoretical yield, and is not isolated, but utilised in the form of the end liquor from the separation of the Chicago acid. The melt from the autoclave is cooled to about 100° C. and tipped into a wood vat containing water (300 gallons). Dilute hydrochloric acid is added (200 gallons of the 30 per cent. acid) and the sulphur dioxide which is evolved collected and recovered. The addition of this acid has a twofold

function. It serves to economise sulphur dioxide and to remove sulphite from the mother liquor where it would interfere with the coupling of the di-hydroxynaphthalene sulphonic acid; and in addition it salts out the Chicago acid, which after twelve hours can be pressed off and purified by solution in dilute soda and reprecipitation with acid. The yield is 35-40 lb. from the quantities mentioned above.

Phenyl-1-Naphthylamine-8-Sulphonic Acid

This acid and the corresponding tolyl derivative are the two substances from which many of the Sulphon Blues have their origin. Both acids may be prepared by the condensation of Peri acid (1-naphthylamine-8-sulphonic acid) with the corresponding amine. The process for the manufacture of the phenyl derivative, phenyl Peri acid (1.1), will be described. Aniline (5 cwt.) is heated in a cast iron vessel with a short return condenser to a temperature of 120° C., and Peri acid (2 cwt.) is added with constant stirring through a manhole, so that the temperature rises to 170° C., at which point it is maintained for 20 hours, after which the melt becomes olive green and moderately fluid. When it has cooled to about 80° C., it is run out into water (400 gallons) with stirring, and neutralised with magnesia (½ cwt.). The dilution just described is done in the body of a still fitted with the usual connections for steam, condenser, etc., and the diluting water used is the aqueous portion of the distillate from a previous batch. Indirect pressure steam heating is applied, and the excess of aniline, together with water, distils over. In this way, aniline is recovered and a concentrated solution of the magnesium salt of phenyl Peri acid remains in the retort; the latter is filtered hot and allowed to cool, when the magnesium salt separates in crystalline form. To obtain the actual acid, the salt is dissolved in hot water, with the aid of live steam, and the solution made just acid with sulphuric acid. On cooling, the phenyl Peri acid separates out and after standing may be pressed off. From the quantities given the yield is just over 2 cwt.

Sulphoncyanin G

In order to illustrate the preparation of the various secondary intermediates from phenyl Peri acid, the manufacture of Sulphoncyanin G will be described. The first operation is the coupling of diazotised aniline with Cleve's θ acid (naphthylamine-1 : 7-sulphonic acid). To this end ice (3 cwt.), water (20 gallons), and aniline (½ cwt.) are mixed, and hydrochloric acid (10 gallons, 22 per cent.) run in, followed by a solution of sodium nitrite (20 lb.) in water (7 gallons), the latter being added at such a rate that the temperature does not exceed 0° C. This is then coupled with the θ-acid (2 cwt.) in the presence of sodium acetate. The resultant intermediate (phenylazo-1 : 7-acid) is not isolated, but is treated with a further quantity of ice and nitrite and the diazo compound so obtained salted out. This is obtained as a deep yellow paste, and is used in aqueous suspension for coupling with the phenyl Peri acid to give the dyestuff (Sulphoncyanin G), which is then salted out in the usual way.

Dyes and Their Application: Recent Technical Progress

By L. J. Hooley

THE polycyclic hydrocarbons which form the basis of many of the vat dyestuffs may be conveniently regarded as being built up either round perylene or pyrene nuclei.

PERYLENE.

PYRENE.

Those from perylene have hitherto formed the larger class, and include, of course, the dibenzanthrones and isodibenzanthrones, formed from anthracene as starting point. In addition, the perylene derivatives produced from perylene itself have become numerous during the last three or four years.

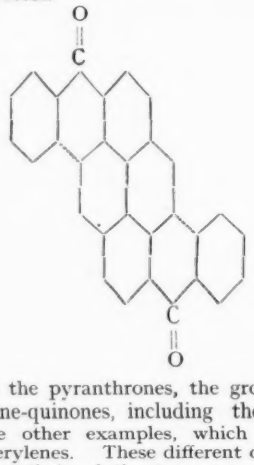
Pyrene Derivatives

The first dyestuff from pyrene was pyranthrone, obtained by Scholl in 1905 from 1 : 1^1-dianthraquinonyl-2 : 2^1-dimethyl by the elimination of water. This was placed on the market by the Badische Co., and is now sold as Indanthrene Golden Orange G., Caledon Gold Orange G., and corresponding brands.

Curiously enough, while perylene has only been synthesised comparatively recently, pyrene dates back to the time of Laurent (1837), who gave the name to a fraction of hydrocarbons obtained in tar distillation, which he considered to be a single body. Later, Graebe restricted it to the mixture of hydrocarbons of formula $C_{16}H_{10}$ forming the principle portion of the fraction. Its constitution was determined by Bamberger in 1887.

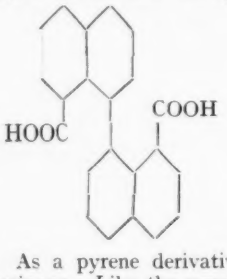
Of the simpler hydrocarbons it will be noticed that it most closely resembles phenanthrene. Like the latter it has a yellow colour. Its difference from phenanthrene, however, can be seen in its behaviour on oxidation, as it gives naphthalene-tetracarboxylic acid instead of a diphenic acid derivative. Another source of the hydrocarbon, and in fact a more convenient one than coal tar, is the "Stuppfett" or mercurial dust obtained in the distillation of mercury in Idria.

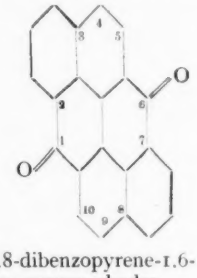
Returning to pyrene derivatives, other pyranthrones have also been obtained, principally by Scholl. Pyranthrone was identified by Scholl as a pyrene derivative by synthesis from 3 : 8-dibenzoylpyrene, which is converted to pyranthrone by his "baking" process.



In addition to the pyranthrones, the group now contains the dibenzopyrene-quinones, including the anthanthrones, as well as some other examples, which make it almost as large as the perylenes. These different derivatives will be formulated to show their relation to pyrene.

Anthanthrone (not anthranthrone, as sometimes given) was obtained by Kalb in 1914, who showed that both the 2 : 2^1 and the 8 : 8^1-dicarboxylic acids of 1 : 1^1-dinaphthyl could be converted by sulphuric acid or other dehydrating agents to the new vat dyestuff.



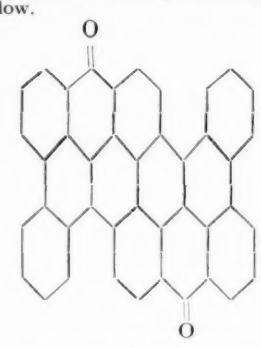


As a pyrene derivative this is 2.3.7.8-dibenzopyrene-1.6-quinone. Like the pyranthrones, it gives orange shades.

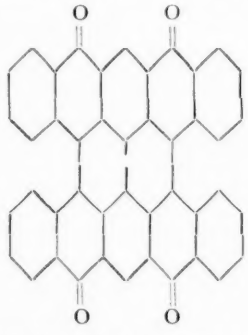
Dibenzopyrenequinones

The newest examples of pyrene derivatives are the differently constituted dibenzopyrenequinones obtained from benzanthrone by condensing with benzoyl chloride followed by further ring closing, or by analogous methods. The simplest of these, 3 : 4 : 8 : 9-dibenzopyrene-5 : 10-quinone, is shown below; it is a yellow vat dyestuff.

As examples of more complex bodies two others may be mentioned: (*a*) 5 : 13-diphenylpyranthrone when oxidised with sulphuric acid and manganese dioxide is converted to another orange product, which presumably has the constitution shown below.



(*b*) Diesbach and Janzen, in the current issue of *Helvetica Chimica Acta*, describe the production of the following body :—

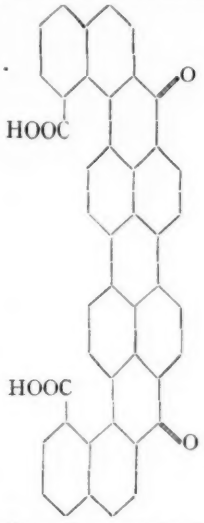


The pyrene nucleus can easily be recognised in the centre of the formula. The authors designate it Tetra-(4¹-oxo-naphthalino-1¹,2¹,3¹)-8, 11, 1-9, 13, 3-10, 14, 4-7, 16, 6-pyrene. It does not appear to have good dyeing properties, as it is described as giving very weak brown-red shades. Its synthesis, however, forms an excellent example both of the reactions used in building up these polycyclic hydrocarbons and of the ease with which these may be obtained from simple ring compounds. Starting from a substituted benzene, namely alpha-nitro-cumidinic acid, 1 : 3-dimethyl-2-nitro-4 : 6-dibenzoylbenzene is obtained by the Fridel-Crafts reaction. The nitro group is then replaced by chlorine and the compound ring closed to the chlorodinaphthanthracene-diquinone. The chlorine serves to join two molecules together by treatment with copper powder in nitrobenzene, and then finally copper powder in sulphuric acid gives the pyrene body.

Among some recent pyranthrones the following may be mentioned :—In B.P.282,913 (British Dyestuffs Corporation, Ltd., Shepherdson, A., and Thornley, S.) derivatives of pyranthrone which are probably amines are obtained by treating pyranthrone with hydroxylamine in sulphuric acid. These derivatives can if desired be benzoylated. Vat dyes giving brown and brown-red shades are obtained. Brown products also result from the condensation of halogenated pyranthrones with aminoflavanthrones, according to B.P. 289,188 (British Dyestuffs Corporation, Ltd., Baddiley, J., Dootson, P., Shepherdson, A., and Thornley, S.). Instead of aminoflavanthrone, aminoanthraquinones may be used, as in U.S.P. 1,596,528 (Newport Co. and Gubelmann, I.)

In addition to anthanthrone itself, Kalb described halogen, nitro and other derivatives. Recent patents dealing with anthanthrone include B.P.260,998, B.P.287,020, B.P.288,957 (L. Cassella and Co. and I.G.F.A.-G.)

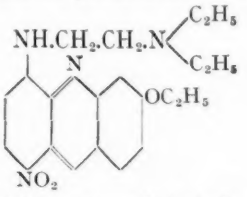
One of the most interesting results obtained is described in B.P.288,666 (I.G.F.A.-G.). By careful treatment of 1 : 1¹-dinaphthalene-8 : 8-dicarboxylic acid, ring closing through one carboxylic acid only may be carried out, giving a benzobenzanthrone carboxylic acid; this can then be subjected to alkali fusion, giving a complicated dibenzanthrone.



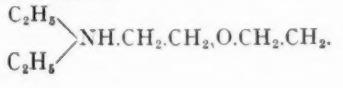
The two carboxylic acid groups in this compound may, if desired, be afterwards closed to give a derivative of the dibenzanthrone type containing 13 rings. Products dyeing in blue and greenish-blue shades are obtained.

Recent Work on Acridine Derivatives

VARIOUS acridine dyes, including anthraquinone acridines, have been recently stated to be suitable for the colouring of acetyl silk. In B.P. 283,510, I.G.F.A.-G. derivatives of type similar to that shown in the formula below are obtained from 9-acridine derivatives, and are powerful bactericides.



Synthetic drugs containing somewhat similar side chains to that shown above have been obtained from acridine azine, triphenyl methane and quinoline derivatives (267,169 I.G.F.A.-G). In 286,087 side chains containing oxygen or sulphur are used, such as



Dyestuffs Markets: The Month's Business in Review

From Our Own Correspondents

Lancashire

AUGUST being the holiday (wakes) month, business generally was a little quieter, but there has been a good undertone and more optimism than has been apparent for some time. The vogue for pale shades appears to have attained permanency, and while in many textile trades it has led to a considerable curtailment of the amount of dyestuffs used, yet it has been accompanied by a demand for coloured material in place of white in other directions, e.g., lingerie and shirtings, which has tended towards adjustment of the balance. So far as the dyer is concerned, this demand for colour must have meant more to do, but piece-work, more efficient machinery and methods, and the entrance of newcomers during the boom period of a few years ago have discounted the increase. Under such circumstances, the present rumours of the amalgamation of certain of the largest dyeing combinations can be understood, whether based on fact or not, as all must be tempted to expand, and with the knowledge that it can only be accomplished at the expense of another section of the dyeing industry.

It is reported that Mr. John Rogers, a director of Imperial Chemical Industries, Ltd., is now in charge of the British Dyestuffs Corporation. It is understood that the association of Mr. Rogers and the British Dyestuffs Corporation dates back to the war period, and he is thus well acquainted with British effort in the dyestuff field. In dyestuff circles the arrangement is taken to be an indication of the importance attached by Imperial Chemical Industries, Ltd., to their holding in the dyestuff industry.

The cotton trade in general would appear to be picking up a little. There is more demand for piece-goods, and the American cotton crop estimate of fourteen and a quarter million bales, while considered low, has provided no sensation and, therefore, has had little influence on the stability of prices. The announcement of the registration of a combination of mills under the name of the Lancashire Textile Corporation is due, and will mark the launching of an attempt to reorganise the cotton trade on more modern and logical lines than has hitherto been considered feasible. The formation of trusts is, of course, attended by many dangers, so well ventilated however by this time that everybody knows them, and in any case they are smaller than those with which the cotton industry is now faced.

Yorkshire

AUGUST, the holiday month, never expected to yield much in the way of turnover, was last year reported to be better than was expected. The turnovers of the month just completed are reported to be better than those of last year's corresponding month, and, although they are less than those of normal months, it would appear that the trade of August is improving year by year. The month of July appears to be qualifying for its place amongst the poor months. The popular holiday season is drawing to a close and one hopes soon to settle down again to steady output. On account of slack trade several mills in Huddersfield closed down for ten days. The biggest demand in that district at present is for medium class worsteds, which have enjoyed a good run. Colne Valley tweeds have experienced recently something in the nature of a slump, but there is hope of better trade in the autumn. The competition of cheap Continental worsteds and the partial closing of several once valuable markets would appear to be among the foremost items of anxiety to the Colne Valley manufacturers.

The heavy woollen district's troubles arise largely from the same causes, but, unlike Huddersfield, the district has no worsted trade from which it could otherwise have derived some consolation, the trend of fashion being distinctly in favour of worsted as against the woollen tweeds characteristic of Dewsbury. Canada and the United States have been satisfactory customers. The trickling through of orders from China is amongst the indications of more settled conditions in that country. There are signs of an acceptable accession of business from that part of the globe, not only for woollens but for cotton pieces as well. The latter will be much appreciated by dyers in Bradford and district, where, prior to the disturbances of the last few years, much work was done for China, particularly in blacks. While a complete revival is still distant there is now prospect of improvement in some dyehouses which for years have been, to use a mild description, sluggish. Makers of Sulphur Black share in the optimistic outlook. An announcement made in the Heavy Woollen District that a local woollen textile firm is connected with a syndicate of manufacturers, with £15,000,000 capital, formed for the reconstruction of Chinese war-ravaged areas, is said to have accentuated interest in the possibilities of the Far Eastern market.

Colonel F. Vernon Willey has made outspoken comments on our wool textile industry, declaring it to be still influenced by mid-Victorian methods and advocating wholesale reorganisation. One who has had many years experience as a manufacturer in the Bradford trade gives a number of reasons for the difficulties which have arisen. Whereas in the 70's it took three individuals 60 hours to carry through certain operations, modern machinery will do the work to-day in half an hour. The reduction in the demand for cloth has undoubtedly been brought about very largely by excessive taxation. The effect of the machinery tax has been to displace up-to-date machinery, manufacturers being unable to pay the excessive tax on the assessment of new machines. Further reasons quoted by the above authority for the present condition of things are the high assessment of mill property, it being 300 per cent. higher than it was 20 years ago; that the mode of taxation is disadvantageous, super-tax coming into operation for mills assessed at over £2,000; and that wages are 50 per cent. higher than in Italy, Germany, Belgium, France and Japan, and these countries are competing with us for raw material.

Scotland

AUGUST has seen business fairly regular in Scotland, and the level of employment for the present times is very satisfactory. Chemical markets have been rather quiet, with a slight weakening tendency in prices. Dyestuff sales have, however, been a fairly good feature during the month. The Scottish woollen industry both in the South and in the Alloa districts is still prosperous. A few of the manufacturers who have not had their new patterns taken up as readily as the majority may be some time getting their looms running, but speaking generally the mills can see sufficient work for some time to come. Orders from America and Europe remain very satisfactory. The hosiery makers are also fairly well supplied with orders, especially in the fancy sections. Wool dyers are not more than moderately busy, and there is little going on in the yarn and piece sections.

Round Glasgow and Paisley districts dyers and printers are better placed, more days per week being worked than a short time ago. Comment has been made before on the satisfactory position of many of the dyeing and cleaning firms in Scotland; recently the well-known Castlebank Dye Works have celebrated their jubilee.

At the very successful Civic Week held in Carlisle in August, Scottish Dyes, Ltd., and many other well-known Scottish industries were represented.

The dispute in the dyeing and printing trades has not advanced nearer solution, but during the holidays it has been practically in abeyance. Further meetings should, however, be taking place during the next few weeks, and the feeling is inclined to be optimistic.

The Natural Indigo Trade

IMPORTS into the United Kingdom of natural indigo have decreased considerably during the past few years. Imports for last year were 257 cwt., valued at £6,524, as compared with 464 cwt., valued at £11,590, in the previous year. India is the most important producer of natural indigo, and during the 1927-28 season the area under indigo was 60,200 acres, as compared with 105,800 acres during the previous season. The estimated output of indigo was 11,200 cwt., as against 21,000 cwt. in 1926-27. During 1927 exports of Indian indigo, mostly from Bengal, amounted to 1,835 cwt., which represents a decrease as compared with the previous year, when shipments totalled 2,005 cwt.

Dyestuffs Monthly Supplement

Published in the second issue of "The Chemical Age" each month

Communications relating to editorial matter for the Dyestuffs Monthly Supplement should be addressed to the Editor, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4. Advertisement matter, subscriptions, etc., should be sent to the Manager. The Supplement is devoted to the interests of both manufacturers and users of dyestuffs, and contributions will be welcomed.

An Achievement

DURING the month, it is reported, the two outstandingly important vat dyestuffs, Indanthrene Brown R and Indanthrene Brown G, hitherto imported from Germany, have been placed on the market by Imperial Chemical Industries, Ltd., in which body, of course, are incorporated the British Dyestuffs Corporation and Scottish Dyes, Ltd. The event is regarded as a notable achievement. The production in increasing measure of these fast dyes is the best evidence of the technical progress of the industry, and their application to fabrics is raising some new problems. "The consumer," our Lancashire correspondent writes, "is apparently not impressed with the slogan of colours guaranteed to last as long as the fabric, but is demanding a fabric that will last as long as the colour." At the conference last week, at Plymouth, of the Association of Chambers of Commerce, resolutions submitted by northern chambers in favour of appealing or amending the Dyestuffs Act were defeated, These matters are dealt with more fully in THE CHEMICAL AGE editorial columns.

B.D.C. Autumn Shades

IMPERIAL Chemical Industries, Ltd., have just issued a list of dyestuffs in the fashionable shades for autumn, 1928, produced at the British Dyestuffs Corporation works. The colours selected are mainly of the delicate character which have been in vogue for some time. They are named Wistaria, Mayonnaise, Ariel, Prawn, Submarine, Pebble, Greenstone, Saracen Red, Lomond Blue, and Chocolate. These are described as only a few suggestions, and the B.D.C. are prepared to give recipes for the matching of any other desired shade on wool or any other material. The dyeing of the colours is carried out, in the manner usual for acid colours, with the addition of 10 per cent. Glauber's salt and 2 per cent. sulphuric acid.

Cellulose-Acetate Silk Colours

THREE very beautiful B.D.C. colours for cellulose-acetate silk are announced by Imperial Chemical Industries, Ltd.—Dispersol Fast Yellow A Paste, Dispersol Fast Orange A Paste, and Dispersol Fast Red A Paste. The colours applied in the proportion of 2.5 per cent. on acetate silk piece give an exceedingly rich and clear tone, and applied to the yarn (10 per cent.) the effect is additionally brilliant without losing its richness and depth. In their method of application and in general properties these dyestuffs are very similar to the B.D.C. Duranol colours. They possess very good fastness to washing, scrooping, alkalis, and light, while their affinity is very good to excellent. The dyeing process is the same as for Duranol colours at a temperature of 75–85° C. (165–185° F.) from a bath containing (if desired) Turkey Red Oil or other soluble oil. In the case of Dispersol Fast Orange A Paste it is preferable to dye in the presence of some soluble oil. When used in combination with other colours, as when dyeing union materials containing cellulose-acetate silk, acids, alkalis, salt, etc., may be added if necessary.

Scottish Dyes' Celatene Colours

OUR readers may remember the favourable notice given in these columns to the original card issued by Scottish Dyes, Ltd., of their Celatene colours. Since then, this series has increased very considerably in use, and the firm have just issued a new edition of their Celatene Colours on Acetyl Silk, containing all their recent Celatene colours, including several not given in the original card. The samples shown on the card include two very beautiful two-colour effects, composed in the one case of Caledon Jade Green and Celatene Orange, and in the other of Caledon Blue RC and Celatene Red Violet. The dyed shades on Celanese yarn represent a fairly wide range from the yellows, browns, reds, violets, and blues, down to Celatene Black. These illustrate the purity and clearness of colour for which the firm's productions are so well-known.

Method of Application

THE Celatene colours are a series fo anthraquinone derivatives specially produced for acetyl silk. Their method of application is simple, and has none of the disadvantages of the earlier method of dyeing this material. In point of fastness they place acetyl silk on a similar basis to wool and cotton. Their fastness to light is in many cases equal to that of the best of the vat colours, and in this respect Celatene Fast Light Yellow, Celatene Fast Light Brown, Celatene Gold Orange, Celatene Orange, and Celatene Red Violet may be particularly mentioned. Celatene colours are dyed in 20–40 times their weight of liquor, the wetted out material being introduced into the warm dye bath, which will not be clear at the start, and the temperature raised in about half an hour to 70–85° C., and maintained at this until good exhaustion is obtained ($\frac{1}{2}$–$\frac{3}{4}$ hour). The material is lifted, rinsed, and dried in the usual way. For dark shades, where complete exhaustion cannot be obtained, it is advisable to use a standing bath, which is made up with five-eighths of the initial quantity.

Two-Colour Effects

CELATINE colours print very readily, only requiring thickening with a suitable gum thickening and a subsequent steaming to fix the colour. They do not dye cotton, and can be used for obtaining beautiful two-colour effects on mixed acetyl silk and viscose or cotton fabrics. They are not recommended for wool mixtures. These effects can be obtained by a one bath process if the viscose is coloured with direct dyes, but to get parallel fastness on the two fibres vat colours should be used, and these require two baths. Cold dyeing vats are the most satisfactory. Caledon Red BN, Red Violet 2RN, Violet RN, Brown R, Yellow 3G, Red FF, and Brilliant Violet R are dyed cold in this way, and Blue GCD, RC, Gold Orange G, Jade Green, Brilliant Purple RR at 35–40° C. After oxidising it is essential to clear the fibre of alkali, and this may be done by a little acid. The acetyl silk is then dyed with the Celatene colour in the normal way, and after completion a soaping is necessary. Two-colour effects are obtained most easily with light and medium shades of similar depth on both materials. Deep shades may be obtained, but greater care is necessary in avoiding hydrolysis and staining, and some loss of dyestuff may be expected.

Sandoz New Colours

FROM the Bradford offices of the Sandoz Chemical Co., of Basle, we have received three new pattern cards, illustrating additions to their acid alizarine, mordant, and vat colours.

Alizarine Light Blue 3 G, which is shown applied to

carpet yarn, viscose, and unweighted silk, is an addition to the firm's range of acid alizarine colours and is notable for its blue-greenish shade, which is said to be more permanent in artificial light than other brands of this class. It is specially noted for its very good fastness to perspiration, water, washing, milling, and excellent fastness to light and hot pressing. It is not sensitive to iron and copper, and when dyed on a chrome mordant or by the afterchrome and chromosol methods its shade is only slightly flatter, consequently it is suitable for shading and brightening chrome colours. Cotton and viscose effect threads are left pure white, silk is dyed equally with wool, and solid shades can readily be obtained on Gloria material. The colour is suitable for the dyeing of felt hats owing to its fastness to light and perspiration, and is also an important colour for dyeing weighted and unweighted silk. It is recommended for the dyeing of carpet yarn and blanket headings, as well as for higher class ladies' and gentlemen's dress material. It is found particularly useful as a self colour or in conjunction with the "fast-to-light" acid dyestuffs for the production of fashion shades.

Omega Chrome Violet BN conc., which is shown as applied to yarn, wool with viscose effects, milled loose wool, and chromosol, is an addition to the firm's mordant colours and is described as possessing excellent all-round properties. It may be dyed as well on a chrome mordant as by the after-chrome method or the chromosol method, but the last named is specially recommended when bright shades are required. Omega Chrome Violet BN conc. is almost as level dyeing as Omega Chrome Blue FB, and consequently is applicable to the dyeing of piece goods. On account of its excellent milling fastness and very good fastness to potting, properties which are very nearly similar to those of Alizarine Blue OCR, the product will be appreciated for the dyeing of all types of wool, slubbing, yarn, etc. It leaves cotton, viscose, real silk and acetate silk effects white.

Sandone Blue R is a new vat dye producing navy blues dyed by either the hydrosulphite method or the hydrosulphite and sodium sulphide method. It is very level dyeing and owing to its very good solubility is recommended for machine dyeing. It is described as particularly suitable for workmen's overalls, aprons, and other materials calling for very good fastness to washing. The pattern card shows it applied to cotton, mercerised cotton, and viscose yarns and to mercerised cotton fabric.

I.G. Dyestuff Plants

PROFESSOR Mullin, head of the Department of Textile Chemistry and Dyeing at Clemson College, U.S.A., in his article on recent visits to the I.G. Chemical works, refers to several points of interest to dyestuff chemists. One is a lamp for testing the fading of colours, which keeps the goods cool while being subjected to the light test; one day's exposure to this lamp is said to equal about three days of sunlight. At Hoechst experiments were in progress with a new Zeiss instrument for the measurement and comparison of colour on solid materials such as textiles. At the naphthol plant at Offenbach, he saw a new blue, stated to be fast to kier boiling and the hypochlorite bleach, and samples of a new red said to be faster to kier boiling than Turkey Red. Professor Mullin also mentions a number of wetting out agents designed to overcome difficulties in certain classes of dyeing.

A New Textile Process

PRESS reports from Manchester announce a "discovery," one effect of which promises to improve artificial silk and cotton mixed cloths, and the formation of a small private Lancashire company to make further tests and to utilise the possibilities commercially. This discovery, believed to herald a revolution in processes, consists of a method for removing natural impurities from grey cotton yarn and for producing a commercially pure cellulose without weakening the tensile strength of the fibre. Experiments continued over a period of years are said to have proved that the process gives a superior handle or feel, an improved appearance and increased affinity to dyes, so that, woven with artificial silk, an almost level colour is at once obtained. No loss of lustre, strength, or quality follows this treatment. Among the directors of the new company are Mr. J. A. Egerton (chairman) Sir Amos Nelson, Mr. W. L. Lishman, (Cornholme Dyeing Co.), Mr. W. Marshall and Mr. W. P. Bridge.

"Dyers Should Go Shopping"

THIS is the advice that an American authority presses upon dyers and dyestuff manufacturers. "Those," it states, "who dye textiles and those who make dyestuffs can learn many things pertinent to their respective trades by going no further than the dry goods counters of any large department store. Endowed with eyes trained to see the qualities and defects in coloured fabrics, both will receive a lesson in modern retailing practice that they will often recall to mind afterward in the course of their daily work. They will be struck with new ideas about dyestuffs and dyeing processes in their relation to dry goods sales. To some dyers it may come as a surprise that such a close relation actually exists between the dyehouse and the dry goods counter.

"While strolling through the aisles of the department store the dyer may rub elbows with those who buy and wear the products of his toil. He will mingle with members of that vast and heterogeneous public known as the Ultimate Consumer, and we wager that he will feel somewhat like a king travelling incognito among his subjects. But apart from experiencing the pleasure of watching housewives buy the goods that his hands have helped to beautify, the dyer will, let us repeat, learn facts about textile retailing that will make him a wiser dyer. Among the most instructive lessons will be his study of the numerous claims made by the retail store as to the wearing qualities of fabrics on sale. The dyer will find that variations in price are less striking than the differences in fastness properties claimed for the same fabric in different stores."

Atmospheric Effects on Textiles

THE influence exerted by excessively dry household atmosphere on the colour and texture of rugs and other textile materials commonly used in homes will be the subject of study by the Holland (U.S.A.) Institute of Thermology, according to an announcement from the Holland Furnace Co., of Holland, Mich. The Institute of Thermology was established only recently. One of its chief objects is to make homes healthier places to live in and to improve the relative humidity in them so that fabrics, furniture, and other goods are not adversely affected. A prominent research engineer will be appointed to direct the investigations and tests, and the results will be placed before the public from time to time in the form of reports of findings. The science of domestic heating and ventilation will constitute the principal field of investigation.

U.S and Russian Dyestuff Production

IT is stated that an agreement has been concluded between the Amtorg Trading Corporation, acting on behalf of the Aniltrest (Aniline Trust) of the Union of Socialist Soviet Republics of Russia and Professor Harry D. Gibbs, of Washington, D.C., for the technical assistance of Professor Gibbs in the organisation of the production in the Soviet Union of a series of chemical products used in the aniline industry. The purchase of the equipment required for these plants will be made in the United States.

Organic Colours for Rubber

A Review of the Present Position

The following notes are taken from a paper on "Organic Rubber Colours," read by Dr. W. J. S. Naunton before the Manchester Section of the Institution of the Rubber Industry, and published in the "Transactions" of the Institution.

DYESTUFFS are divided into about twelve main groups according to their method of manufacture; thus we have the sulphur colours which are made by fusing together various organic compounds with sulphur and sodium sulphide, the azo colours in which the intermediates are coupled together by means of the diazo reaction, and so on.

Most of the organic dyestuffs may be regarded as salts in which either the coloured organic base is combined with a colourless inorganic acid (basic dyes) or the coloured organic acid is combined with a colourless inorganic base (acid dyes). This salt formation has in most cases rendered the colour soluble in water. In the absence of salt-forming groups in the coloured compounds, or when their action is insufficiently potent, the resulting substances are sufficiently insoluble in water to be of direct use in the rubber industry; examples of such pigments are Monolite Yellow and Monolite Red.

Use of Water-Soluble Dyestuffs

A consideration will be made of the method of employing the water-soluble dyestuffs, which are far more numerous than the insoluble ones, in the colouring of rubber. The obvious way is to convert them where possible into lakes or insoluble coloured compounds. The two most important processes of lake making are (1) precipitating an insoluble salt of the soluble dyestuff upon a suitable white pigment, known as the "lake-base" and (2) employing a mineral earth which absorbs certain dyes from aqueous solution. A word of warning should be added here with regard to lakes prepared by absorbing colours upon mineral earths: the commonest absorbent is a mineral known as "green earth," which unfortunately more often than not contains traces of manganese, which renders its use in rubber colours highly undesirable.

It has been suggested that the rubber compounder could to all intents and purposes prepare his own lakes by simply pouring a solution of the dyestuffs over clay, but there appear to be three serious objections to this procedure; firstly, it is not easy to balance the amount of colour and clay to give a pigment fast to water; secondly, the resulting dried clay mass is in some cases far from easy to grind; and thirdly, the rubber man prefers to purchase satisfactory colours from the colour manufacturer.

Mention should also be made here of the use of special vehicles for conveying the colour into the rubber, such as the various substitutes and synthetic resins. Unfortunately, white substitute and most of the synthetic resins do not actually dissolve in rubber, and hence are not ideal vehicles for this purpose.

Briefly, the testing of rubber colours is directed towards the moisture content, the fineness, freedom from water-soluble colour, shade, strength, light-fastness, bleeding, and general conditions of service.

Effect on the Ageing of Rubber

Experiments were made to find the effect of organic colours (two typical inorganic colours—namely, ultramarine and red oxide of iron, were included for comparative purposes) upon the ageing of rubber. The basic mix employed contained: pale crêpe rubber, 100 parts; zinc oxide, 6 parts; lithopone, 22 parts; catalpo, 50 parts; magnesia, 2 parts; sulphur, 2 parts; tetraethylthiuramdisulphide, 0·375 part. The proportion of the following dyestuff or pigment added was adjusted to give a full shade, and is expressed as a percentage on the above mix; ultramarine, 6; red oxide, 6; Vulcafor Red, 2; Vulcafor Yellow, G 2; Vulcafor Orange, 2; Vulcafor Scarlet, 2; Vulcafor Green, 2; Vulcafor Blue, 0·75; Vulcafor Yellow I, 0·35; Vulcafor Yellow IV, 0·35; Vulcafor Red III, 0·35.

The cure in all cases was 10 minutes in the press at 40 lb. per sq. in. The sheets were 2 mm. thick. The sheets were tested 24 hours after curing, after 14 days in the Geer oven at 70° C., after storage in the dark for six months, and after exposure (both sides) in the open for six months.

The general procedure in the testing was that recommended by the Physical Testing Committee of the Division of Rubber Chemistry of the American Chemical Society. The results showed that the colours appeared to have a bad influence upon the heat ageing, but a good effect upon the normal ageing of the rubber.

Further experiments were therefore made with similar compounds, but this time with the addition of 1 per cent. on the rubber of a chemical anti-ager (Nonox). Unfortunately, time did not allow of an equal time of exposure, but parallel experiments in the Geer Oven demonstrated that on the whole the colours now had little if any effect upon the heat ageing of the rubbers.

The application of organic colours may be considered under three main headings: (*a*) latex, (*b*) soft rubber, and (*c*) ebonite.

Colouring of Latex

The colouring of latex is naturally assuming greater importance with the development of processes for its commercial application. Broadly speaking, when the latex is to be vulcanised at or slightly above the ordinary temperature by means of super-accelerators, almost any dyestuff may be employed to colour it, provided the dyestuff carries a negative electric charge, and hence does not bring about coagulation.

Whether or not it is economical to employ water-soluble dyestuffs in the colouring of latex will depend upon the use to which the latex is to be put; generally speaking, when the serum is to be separated from the rubber by any means other than evaporation, it will be found to be uneconomical owing to the loss of colour in the water. When it is intended to compound the mix in the latex itself, then by the use of a suitable filler, such as China Clay, the unbound water-soluble colour may be fixed and the finished goods will not require to be surface washed to remove any free colour.

Of course, the pigment colours and lakes may be employed in such water compounded mixes, but for this purpose especially, they must be in a fine state of division since the dispersing action of milling in a plastic (in this case rubber) is now absent. In practice, of course, the absence of milling usually gives rise to the necessity of putting the pigment through one of the mechanical colloid mills.

There is another interesting application of organic dyestuffs to the colouring of latex, and that is the use of vatable dyestuffs. These compounds are insoluble in water, but become soluble when reduced to their leuco compounds by any of the common reducing agents. The soluble form of the dye is mixed with the latex, which is then agitated in air when the dyestuff oxidises to its insoluble form upon the rubber particles.

Electro-deposition

In the more recent development—namely, the electro-deposition of rubber, still further limitations are encountered, since now, not only must the colour be fine enough to give uniform colouration to the eye, but it must be fine enough to travel in the electric field and be deposited with the rubber at the anode; in other words, it must possess a particle size comparable with that of the rubber particle in latex. It is now necessary to revise completely the old ideas of fineness, since what was formerly considered to be of excellent fineness must now be regarded as coarse, in fact, it is necessary to prepare the colours in colloidal solution. In some cases, by adjusting the conditions of the reaction, the pigments may be prepared in the colloidal state, or at least in a state of subdivision approaching that state, and after the removal of the inorganic impurities it is only necessary to add a suitable protective colloid in order to maintain the pigment in that state; in other cases this is not possible, and it is necessary to resort to other methods of dispersion. The method which will immediately suggest itself is the colloid mill, but it is a remarkable fact that with many of the organic pigments the colloid mill will only reduce them to a certain state of division, quite fine enough for ordinary water compounding, but not fine enough for electro-deposition, and repeated passage through the mill will not alter this state of affairs.

The main requirements of pigments of the electro-deposition process are therefore, (1) that the pigment should have a nega-

tive electric charge, and (2) that it should have a particle size comparable with that of latex and be free from coarse particles, which would settle out in the bath instead of being deposited on the anode.

The colours for this purpose can be tested by the usual methods, such as by placing the emulsion under distilled water in a U-tube containing electrodes, or by placing a drop on a microscope slide fitted with tin foil electrodes (method of Cotton and Mouton).

Colouring Soft Rubber

The whole key to success in the production of brightly coloured rubber is the use of accelerators. In fact, one of the most difficult problems of the rubber colourist when an accelerator is employed is to find a range of colours which are completely fugitive in a white mix during cure, in other words, a range of marking colours for distinguishing between uncured white mixes. A few of the basic dyes will bleach out during the cure, but will re-develop again after standing for a few hours. It will be seen, therefore, that almost all of the organic colours are more or less fast to the curing conditions of rubber in the presence of a super-accelerator. They do not, however, all constitute good rubber colours.

Organic rubber colours can be divided into three main classes : (1) soluble in rubber, (2) an intermediate class slightly soluble in rubber, (3) insoluble in rubber. The first two classes are purely organic dyestuffs, but the third class may be divided into two groups : (a) organic pigments, and (b) lakes.

The most common rubber soluble colours are the reds and yellows, but it must not be supposed that blues and violets are lacking. Such colours exist and are exceptionally fast to light, but perhaps they are rather too expensive for every-day use. These colours are possessed of one great failing as a class, and that is that not only do they dissolve in rubber, but they crystallise from rubber. To use them successfully, it is necessary to determine their solubility at the ordinary temperature in the particular mix and not to exceed this concentration. In ordinary pale crêpe, this figure is very low indeed, about 0·3 per cent. If this figure be exceeded, the dyestuff will crystallise out and the crystals will slowly migrate to the surface of the rubber with the production of a dull brown " bloom " (in the case of Vulcafor red III). Certain substances, to which reference will be made later, tend to delay this crystallisation ; but still more remarkable is the fact that certain substances, which one would expect to be quite inert in this respect, tend to accelerate it.

The incorporation of these colours into the rubber is often attended with difficulties owing to the big difference in solubilities at milling and curing temperatures. A small speck of dyestuff may remain undissolved after the milling, but during the curing will dissolve and produce a darker coloured spot, which owing to diffusion becomes a regrettably large blot. Various attempts have been made to overcome this difficulty, such as prolonged grinding of the colour with some white pigment such as blanc fixe, but with only partial success. There is, however, a method by which not only can easy incorporation be secured, but also a slight improvement in the risk of " blooming," and that is first of all to convert these colours into their stearates by melting them with about twice their weight of crude stearic acid.

Colours Slightly Soluble in Rubber

Colours slightly soluble in rubber are unfortunately comparatively few in number. Probably the most characteristic members of this group are such colours as Vulcafor Yellow and Vulcafor Scarlet. These colours are not sufficiently soluble to bleed from one piece of cold rubber to another. For most purposes this class of colours is ideal.

Colours insoluble in rubber may be subdivided into the organic pigments and the lakes made from water-soluble organic colours. Generally speaking, if it is possible to use an organic pigment as such it will be found to be more easily dispersible in rubber than the corresponding lake, although for certain purposes the lake is to be preferred.

Two special applications of organic colours, for the production of transparent rubber and jazz effects, may be considered. The pale crêpe to be used for transparent rubber should be as free as possible from suspended matter, and great care should be taken to ensure that the rubber and compounding ingredients are perfectly dry, or turbidity will result during the cure. The accelerator and activator should be selected with a view to perfect solubility in the rubber. Zinc or cadmium stearates are perhaps the safest activators, since there is less danger of undissolved particles than when the oxides are employed. With regard to the most suitable colours, the ideal ones should be perfectly soluble in the rubber and used at such concentration that there is no fear of any separation or blooming on storage. Rubber soluble colours are, however, not absolutely essential, since certain colours which give in rubber colloidal dispersions which do not aggregate may be employed with success.

Jazz Effects

In many of the early attempts to produce marbled and jazz effects, the coloured pigment was simply dusted upon the mix as it passed through the calender. Needless to add, the result was neither pleasing nor practical. The best effects can only be obtained by the partial mixing of different portions of the basic rubber compound into which the various coloured pigments have been properly incorporated.

There are three important considerations to be kept in mind in the production of these effects. (1) The colours employed must be practically insoluble in rubber, both in the cold and during the cure. In steam cured goods, the selection of pigments is still further narrowed down, since some colours which do not bleed in press cures will do so in open steam. (2) The various portions of coloured mix should be of the same plasticity when put through the rolls, producing the jazz effect, and (3) the degree of mixing must be just sufficient to give the effect and no more, or dull patches will result from the blending of complementary colours.

A novel method of obtaining a far more natural marble pattern is to split the rubber as it leaves the calender upon which the jazz mixing has been effected (U.S.P. 255,017). Incidentally it may be mentioned from the æsthetic point of view that a pleasing jazz will always be found to contain a predominance of white, or some bright colour, such as yellow.

Colouring Ebonite

In the colouring of ebonite there is the obvious difficulty of covering up its natural brownish-black colour : this involves the use of a large proportion of colour. It is true that this colour can first of all be covered by the use of a white pigment such as lithopone, but then it is necessary to overcome the hiding power of the white pigment, and furthermore the introduction of the inorganic pigment tends to give rise to a stone-like ebonite. In most cases the brightest results can be obtained by the correct balance of both white pigment and colour. In fact, in the case of the darker colours the use of a white pigment is essential, since at the necessary concentration these colours are in themselves very dark. With the paler colours, however, such as yellow or orange, quite bright products can be obtained in the absence of inorganic pigments with consequent improvement in physical properties.

In the successful production of coloured ebonite it is necessary to balance the three factors of time, temperature and sulphur. If it is intended to work at comparatively high tematures such as steam at a pressure of fifty pounds per square inch, the key to success is to keep the sulphur down to a minimum, which may be taken as about 30 parts of sulphur per 100 parts of rubber after due consideration has been paid to any sulphur which may be absorbed by any other substance in the mix.

It is unfortunate from the point of view of coloured ebonite that the action of accelerators in its production differs fundamentally from their action in soft rubber, inasmuch as the accelerator, has no effect upon the physical properties of the vulcanisate, and hence the sulphur cannot be greatly reduced. The accelerator merely speeds up the inevitable result. Their beneficial effect consists in either reducing the temperature of the cure or in shortening the time. If powerful accelerators are not used carefully they actually do more harm than good in the production of coloured hard rubber, since under certain conditions they tend to generate sulphuretted hydrogen which, apart from the harmful effect of the resulting micro-porosity upon the ease of polishing of the product, actually tends to destroy the colours by reduction. Since many of the best ebonite colours, especially the vermilion substitutes, are of the class of vat dyestuffs, this generation of a reducing gas is especially harmful. It can, however, be avoided by employing a well regulated rise in curing temperature.

In thick layers on masses of accelerated mix, this generation

of gas may become sufficiently powerful and spontaneous to take on the character of an explosion, and cases are known where quite heavy presses have been completely disrupted by this effect.

In conclusion it is safe to affirm that the organic colours have made possible the production of the bright effects which have done so much to popularise the use of rubber in many new directions. It is not expected, however, that these special colours will replace the old standard inorganic colours for many purpose in which brightness is not an important factor.

Basic Intermediates for Dyestuffs: No. XXIII.—Diphenylamine and Its Derivatives

By "Consultant"

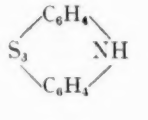
THE manufacture of the dyestuffs of the Metanil Yellow and Orange IV type utilises a certain amount of diphenylamine as such, whilst the condensation of methyldiphenylamine with ketonic compounds such as Michler's ketone, or with *p*-dimethylaminobenzoyl chloride, gives a series of acid dyes, which, although not of the first importance, have a certain place among industrial dyestuffs. The chief way in which compounds of diphenylamine are used is in the preparation of the so-called sulphur dyes, in which the sulphurisation of a nitroderivative of diphenylamine leads to the formation of a complex vat dye. In this connection it is worth mentioning that by the action of sulphur chloride upon diphenylamine itself, Orloff (*Zeit. für Farbenindustrie*, 1928, p. 121) obtained a trithiodiphenylamine (142), which on nitration gave a compound which gives fast red shades on wool from an ammoniacal solution. Further, by the action of phosgene on diphenylamine the well-known Diphenylamine Blue is obtained, which is a member of the triphenylmethane series. If thiophosgene is substituted for phosgene in this preparation, only a small trace of the Blue is obtained, the bulk of the product being a deep wine-red compound which has no pronounced dyeing properties.

Diphenylamine

The preparation of diphenylamine itself is a comparatively simple operation, and the method generally used on an industrial scale depends on the reaction :—

$$C_6H_5.NH_2 + H_2N.C_6H_5 = C_6H_5.NH.C_6H_5 + NH_3$$

a reaction which only proceeds to an appreciable extent in the presence of hydrogen chloride, which removes the ammonia. It may be added that Sabatier and Senderens (*C.R.*, 1904, Vol. 138, 457, 1257) obtained a small yield of diphenylamine during the passage of a mixture of aniline vapour and hydrogen over a heated nickel catalyst. In actual practice the diphenylamine is made by one of two methods—the heating of



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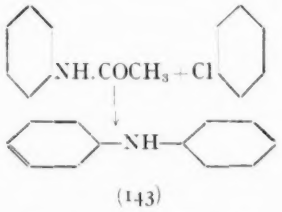

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aniline with aniline hydrochloride, or by Contardi's process, in which zinc chloride is used as a condensing agent. Two other processes are commonly described in textbooks, namely, the condensation of chlorobenzene with acetanilide (143) in the presence of cuprous iodide as a catalyst, and of potassium carbonate to remove the acetic and hydrochloric acids ; and the same process with brombenzene, but these latter are only of academic interest.

The Hydrochloric Acid Process

In the hydrochloric acid process the following details are more or less closely adhered to. The reaction is conducted in a thickly enamelled autoclave so that no traces of copper or iron can get into contact with the batch. The presence of either of these metals leads to a considerably decreased yield of diphenylamine. Dry and granular aniline hydrochloride (1 cwt.) is placed in the autoclave together with redistilled aniline (80 lb.), and the whole heated under pressure to 260°C., for which purpose a bath of fusible metal is recommended (one part of tin, four parts of lead). The pressure is not allowed to rise above 5 atmos., and a release valve is provided by which the ammonia can be blown off automatically when this pressure is reached. The temperature is maintained at 260° C for about twelve hours, but stirring which should have proceeded slowly throughout the operation is continued until the temperature has dropped to below 80° C., at which point the mixture is poured out into strong hydrochloric acid. The acid solution is maintained at boiling and decanted from any solid matter. On diluting the acid solution the diphenylamine is precipitated, but the aniline hydrochloride remains in solution.

The diphenylamine so prepared is best purified by drying followed by distillation in vacuum, although superheated steam at 200° C. will effect purification almost equally well. The yield is only about 75 per cent. of the theoretical, since a part of the aniline always remains unchanged at the end of the operation. It is economised by using the clear diluted liquor after the precipitation of diphenylamine for the preparation of more aniline hydrochloride. An alternative method of purification is to allow the molten contents of the autoclave to solidify, and to grind them in a ball mill with dilute hydrochloric acid until free from aniline salts. The grinding must not be too prolonged, or the diphenylamine will be reduced to such a state that subsequent filtration becomes difficult.

There is a so-called " Catalytic Process " for the preparation of diphenylamine, but this in reality only proves to be a slightly modified form of the process just described, in which a small quantity of hydrochloric acid is added to a large excess of aniline to produce the charge for the autoclave. A modification of more interest is the use of ferric chloride and copper bronze in the production of diphenylamine from aniline. The aniline is heated with one-half its weight of ferric chloride (with $6H_2O$), together with one-twentieth its weight of copper bronze and one two-hundredth of its weight of iodine. The advantage of this process is that large pressures need not be used, the reaction being conducted at 110 lb. pressure and a temperature of 238° C. The yield is not particularly good, and the product is very deeply coloured.

Contardi's Process

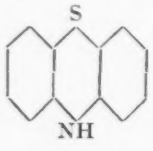
The first stage in Contardi's process is the preparation of the double salt of zinc and aniline hydrochloride. This has the constitution $ZnCl_2$, 2 $(C_6H_5.NH_2.HCl)$, and may be prepared by mixing the appropriate amounts of zinc chloride, aniline, and hydrochloric acid. This substance is heated with twice its weight of aniline. A better way is to heat aniline (9 parts) to boiling in a cast iron digester fitted with stirrer and return condenser, and to add zinc chloride (2¼ parts) and ammonium chloride (1 part). Heating is continued until no more aniline drips back from the condenser, when more aniline is run in and the heating and addition of aniline continued until the vessel is almost full. At this stage vacuum is applied, and any excess aniline distilled off, after which the diphenylamine itself may be distilled off in a pure state until only a small residue remains in the retort. This residue is able to convert a further amount of aniline to diphenylamine, and in all will serve five times for the preparation in this way, after which its efficiency becomes impaired and the vessel must be cleaned out and operations commenced afresh. The reactions which are responsible for the cycle of operations are shown below :—

(1) $ZnCl_2$, $2(C_6H_5.NH_2.HCl) + 4C_6H_5.NH_2 = 2(C_6H_5)_2NH + 2NH_4Cl + ZnCl_2.2(C_6H_5.NH_2)$.

(2) $ZnCl_2$, $2(C_6H_5.NH_2) + 2NH_4Cl = ZnCl_2$, $2(C_6H_5.NH_2.HCl) + 2NH_3$.

The diphenylamine obtained from the final vacuum distillation of either of these processes is a white or very sligh

yellow compound. It crystallises in large white plates, has a pleasant odour, and melts at 54° C. Its high boiling point (310° C.) has led to its adoption as a substance for high temperature baths, and it is used in the laboratory, dissolved in strong sulphuric acid, for the detection of small traces of nitric acid, which produced a deep blue colour with such a solution. In addition to the uses mentioned for diphenylamine in the first paragraph, it gives on melting with sulphur the compound thiodiphenylamine (144), the parent substance of the thionine dyes, and by heating to a fairly high temperature (300° C.) with aliphatic acids such as, for example, oxalic acid, it gives rise to acridide compounds (*cf.* 145). Many of the acid dyestuffs are made from methyl diphenylamine, a liquid boiling at 291° C.



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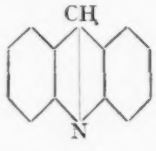

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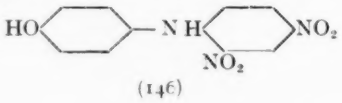
Derivatives of Diphenylamine

The methyl compound may be prepared by the action of methyl sulphate upon the diphenylamine, but it is cheaper to methylate by the use of methyl alcohol under pressure. In this case the diphenylamine (2 cwt.) is mixed with hydrochloric acid (1⅛ cwt.) and methyl alcohol (½ cwt.), and the mixture heated to 200-250° C. for 10-12 hours. The mixture is cooled somewhat and poured into concentrated hydrochloric acid, when the hydrochloride of diphenylamine, which is solid, may be separated from the liquid hydrochloride of methyldiphenylamine by filtration. On causticising the solution of methyldiphenylamine hydrochloride, the base itself is precipitated as an oil, and may be purified by distillation in vacuum.

Of the other derivatives of diphenylamine, those used in the preparation of the sulphur dyes are the most important. Thus, hydroxydinitrodiphenylamine (146) is prepared from *p*-aminophenol and 2 : 4-dinitrochlorbenzene, and is used for the preparation of Immedial Sky Blue (Pyrogene Direct Blue), etc. The condensation is a remarkably simple one ; equivalent quantities of the two compounds are stirred together at 40-50° C. in the presence of calcium carbonate or sodium acetate.



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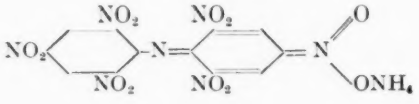

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The indophenol from 4-hydroxy-4′-methyldiphenylamine is used in the same way for the production of Thionol Blue 2B (BDC) (Thionone Indigo B, Sulphur Blue L, Immedial Indone R). It is of interest to note that at one time the hexanitro derivative of diphenylamine (in the form of its ammonium salt 147) was used as a yellow silk and wool dye under the name "Aurantia." Its use at the present time is restricted to the manufacture of photographic colour screens.

Dyes and Their Application : Recent Technical Progress

By L. J. Hooley

Dyeing of Furs, Leather and Animal Substances

LEATHER and furs, as well as feathers, hair, skins, hides, pelts, chamois, bone, horn, ivory and such substances are similar to wool and silk in their general differences from vegetable substances, and in dyeing present analogous problems. The differences are, however, more accentuated than with wool and silk, and the technique of manipulation varies with each type of substance as well as with individual specimens of the same type.

Greater care is necessary in avoiding damage, and the presence of grease, fat and other animal substances causes complications, while the materials cannot be given the treatments permissible with wool and silk. With leathers there are the additional influences of the different tanning treatments, e.g., the chrome, oil, vegetable, and alum methods, to be taken into consideration.

Preservation of Distinctive Properties

Softness, lustre and the other physical properties, which give the different furs and leathers their distinctive qualities, must be preserved. With skins, for example, unless special care is taken, the dyeing process renders them liable to dry hard. In the case of furs, the lustre and natural lie of the hair must not be lost, while often it is necessary to apply the colour so that the shade changes from the tip to the root of the hair, in imitation of natural effects. With feathers, there is very great difference between the fur-like outer portions and the hard, scaly parts of the quill. Feathers from different sources vary widely in character, from soft down to hard material which is only penetrated with difficulty. Hair and bristles, including human hair, offer also their own special problems. In addition there are substances such as mother-of-pearl, which are coloured for buttons, and bone, horn and ivory, which may be considered in the same category. It will be seen, therefore, that the colouring of these materials requires skill and practical experience if satisfactory effects are to be obtained, and are in fact of more importance than the dyestuffs themselves.

The dyes used belong principally to the acid, basic, direct and mordant classes, including as well some vegetable dyes. There are also special dyes which will be mentioned later. The methods of pre-treatment are as varied as the materials to be coloured, but are comparatively gentle. Owing to difficulties of penetration and of getting uniform results, the most soluble and most easily levelling dyes are generally chosen. Often total immersion of the material has to be avoided ; skins, for example, may be dyed in pairs with the flesh sides together, to keep the dye liquor from these parts. Staining is widely adopted, and colours are also applied by brush and spray.

Dyes from Phenylenediamines

Among the dyes which are special to the animal fibres of the fur and leather type, the most important are those obtained from amines, especially those produced on the material by oxidation. Constitutionally, these probably belong to the quinone-imines. The simplest products used are the easily oxidisable *m*- and *p*-phenylenediamines and *p*-aminophenol ; oxidation is effected by substances such as hydrogen peroxide and potassium bichromate.

A typical method of application in the case of, for example, a fur, is to scour, rinse, and then allow to steep for several hours in a cold weak solution of bichromate. The fur is then placed in a weak solution of the hydrochloride of the diamine, with a little vanadium salt added as oxygen carrier, and allowed to stand until the requisite shade is obtained. According to the strength and time of treatment this will be brown or black. The shades given by the older amines were more or less restricted to browns and blacks or variations of these.

Varied Colours

In a recent patent, B.P. 189,046 (I.G.F.A.), by using a suitably substituted *p*-aminophenol in conjunction with a diaminophenol ether, shades from claret to violet and blue are possible. Thus a bordeaux results from treatment in a bath with 0·075 per cent. *p*-aminophenol hydrochloride, 0·125 per cent. 2·4-diaminoanisole, 0·05 per cent. ammonia, and 0·1 per cent. hydrogen peroxide. The tints will be deep reddish if an iron, chromium or copper mordant is used before

dyeing. *m*-Aminophenol, 2:6-dichlor-4-aminophenol, 2:4-diaminoanisole and 2·4.diaminophenetole are also mentioned. In a similar patent, B.P. 189,054, by the same applicants, halogen or nitro derivatives of *p*-aminophenol are used, greenish and reddish browns being obtainable.

The aminophenols and phenylenediamines are often put up in special preparations, designed for producing particular shades, as in the old Ursols, Furrols, Furreins and Nako colours.

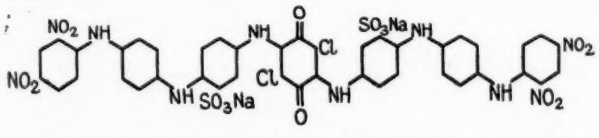
A. J. Hall and the Silver Springs Bleaching and Dyeing Co. (B.P. 270,075) use, instead of phenylenediamines, the diamines of diphenylamine, e.g., 2:4-diaminodiphenylamine, along with hydrogen peroxide.

Yellow shades are obtained by a process analogous to some of the above in B.P. 274,999 (I.G.F.A.), where aminodiphenylamines are again used. A diaminonaphthol, probably the 1:6:8-isomer, has also been recently recommended for the dyeing of hair and feathers, with the use of mordants and oxidation (F.P. 618,723, I.G.F.A.).

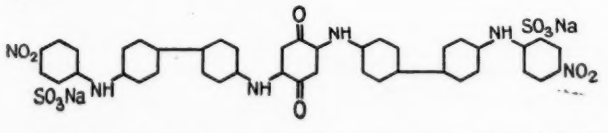
Amino compounds occasionally cause skin trouble; the effect appears to be partly an individual one, and probably connected with the general state of health of the person affected rather than by the amines acting as general poisons.

In B.P. 269,583 (I.G.F.A.), *p*-diamines are obtained in form suitable for colouring hair, including living hair, by treatment with sulphur dioxide, water being absent. The products are thus easily soluble in water and also quite stable. The conversion may be carried out in benzene solution, the products coming out of solution as formed.

Dyes which may be applied directly to fur and the like without the necessity for an oxidation treatment can be synthesised by condensing a benzoquinone with a nitroaminodiphenylamine sulphonic acid (B.P. 219,763 M.L.B.) or a nitroanilidodiphenylamine sulphonic acid. Thus the product of formula shown below gives browns with a greenish shade, previously only obtainable from mixtures of dyestuffs.



Closely similar to the products of the last patent are those of G.P. 431,776 (I.G.F.A.), where a diaminodiphenyl or a diaminodiphenylmethane is condensed, first with a chlornitroarylsulphonic or carboxylic acid, and then with benzoquinone.



The dye of the above formula gives tobacco-brown shades on leather.

The dyestuffs produced by the oxidation of amines on the fibre are probably of similar general structure to the chain compounds shown in the formulæ.

As already mentioned, direct, acid and wool dyes can be used for leather. The number of dyes of these classes which might be used is, of course, large, although the number actually used in practice is more restricted. Some new products for this purpose are protected in B.P. 247,187, these being acid azo dyes obtained according to the following scheme :—

Amine → Resorcinol ← Aminonaphthol ← Amine.

Treatments for Scouring, Levelling, etc.

As stated earlier, variations in properties between individual parts of the same material, and the presence of foreign substances, cause great difficulties in obtaining level dyeing and proper penetration, and this difficulty is not lessened by the fact that the materials cannot be subjected to severe treatments before colouring. Assistants, if of suitable type and if they do not produce secondary effects, are therefore of great advantage. The recent extensions in the production of wetting agents should therefore be of assistance here. Recent developments are not numerous, but a few of them are brought forward below.

Recent Developments

In B.P. 279,942 (B.D.C., R. S. Horsfall, and L. G. Lawrie), the solubility of dyes in water is increased by the use of phenols, particularly resorcinol. The phenols, being hydroxylic solvents and also good solvents for organic substances, are especially suitable for this purpose. Generally, it is not easy to dissolve organic substances, except those of low molecular weight, in mixtures of water and organic solvents. The higher fatty alcohols, which might otherwise be suitable, are not sufficiently miscible with water. With the phenols abovementioned, quite deeply coloured solutions can be obtained with which furs, bone, ivory, horn, resins and celluloid films can be coloured.

Unlevel results in dyeing skins, hairs, etc., are avoided in D. R. P. Appn. J. 27,621 (I.G.F.A.) by giving preliminary soakings in solvents of inorganic or organic acids or salts. A solution of sulphuric acid of 0·1-0·3 per cent. strength is mentioned, and the soaking is done at room temperature.

N-alkylomegasulphonic acid derivatives of aminoanthraquinones and other amino derivatives, containing no other sulphonic acid groups, and which have previously been used for dyeing acetyl silk, are found to be very satisfactory for fur. Dyeing with these latter is done under circumstances such that hydrolysis does not take place (B.P. 268,952, B.D.C. and R. S. Horsfall).

The soluble products obtained by condensing urea with an aldehyde, particularly as described in B.P. 151,016, 171,094, 213,567, have an excellent protective action upon animal fibres, and may be used in processes where alkali or acids are present, to prevent deterioration (B.P. 285,554, B.D.C., Horsfall, R. S., and Lawrie, L. G.)

Finally, the treatment with ozone known as the "Zair" treatment, for increasing the affinity of animal substances for dyestuffs, may be mentioned. An account of some trials of the process will be found in the *Journal of the Society of Dyers and Colourists* for the current year, page 230.

Dyeworks Explosion Inquest

At an inquest held at Huddersfield on Thursday, September 27, light was thrown upon the cause of the explosion which occurred at the Turnbridge Works of the British Dyestuffs Corporation on Monday, July 16, and resulted in the death of two men, Thomas Mullarkey, a chemical foreman, and Edgar Blagborough, a greaser.

Robert Lamb, chemical labourer, said that he was working with Mullarkey on the morning of the occurrence. On the previous Saturday Mullarkey had told witness to light the gas under one of the autoclaves. This he did. He understood that it was dangerous to "blow off" an autoclave if any of the lights were burning under it. When Mullarkey gave instructions for the autoclave to be "blown off" it did not occur to him that Mullarkey had perhaps forgotten that he had given instructions for the lights to be lit, not did it occur to him to remind him.

Dr. Morley, a chemist of the Dyestuffs Corporation, said that Mullarkey was an experienced charge hand. They were engaged in the manufacture of diethyl meta toluidine, and when the autoclave was discharged it would give off alcohol vapour, together with ethyl chloride, a highly inflammable mixture. Mullarkey knew it was dangerous to "blow off" an autoclave if there were any lights near, and he must have forgotten that he had given instructions for the lights to be lit.

The jury returned a verdict of "Accidental death," adding that they were of the opinion that there was carelessness on the part of those responsible.

New Artificial Silk Factories

In the textile industries, the feature of the past week has been the announcement of a number of plans for the erection of new artificial silk factories at Derby, Doncaster, and Kendal, and for augmenting the output of existing works. In Manchester, a more promising volume of inquiry for cotton piecegoods has been noticeable, particularly on Indian account, and this has resulted in a fair amount of business, but trade generally has not expanded to the extent expected. Buyers are still waiting for cotton prices to settle down.

Dyestuffs Markets: The Month's Business in Review

From Our Own Correspondents

Lancashire

There is little change in the dyestuff market to report; the demand can be described as fair, and at that somewhat better than the average of last year. The loss of trade in cheaper materials and the ever increasing demand for faster colour are reflected in the changing balance of the dyestuffs in use. The high cost of the application of the faster dyestuffs acts as a brake on the swing over, which is all the more healthy for its slowness in view of the many problems still unsolved and the doubtful all-in merit of the results in the case of many textiles. Lack of penetration in some instances might be cited, and the fact that a fast colour has been rubbed off instead of dissolved off the fabric in the household wash does not make the result any more satisfactory.

Interesting features of the change are the new problems which have been presented to manufacturers by the longer life conferred on cotton fabrics by the faster dyestuffs. The consumer is apparently not impressed with the slogan of colours guaranteed to last as long as the fabric, but is demanding a fabric which will last as long as the colours, and she will probably get it.

During the month it is reported that the two outstandingly important vat dyestuffs, Indanthrene Browns R and G, hitherto imported from Germany, have been marketed by the I.C.I. group, and the event is looked upon as a noteworthy achievement.

The cotton trade has had a somewhat better month but the general position is still the same and unsatisfactory. It was confidently expected that the scheme for the amalgamation of many of the American yarn spinners involving the formation of a holding company to be called the Textile Corporation would be successfully launched at the beginning of the month, but it is still hanging fire. The recommendation of short time equivalent to a fortnight's closing down during the months of September and October does not indicate too good a state of affairs in the cotton spinning section, but is not considered to indicate that the position is becoming worse.

The extension of Messrs. Wardles' works at Leek, in conjunction with Messrs. Grout and Messrs. Gillet, of Lyons, arising from the working of the Safeguarding of Industries Act, is being watched with interest as indicating a possible revival in the natural silk trade, and taken in conjunction with the establishment of English factories by American hosiery manufacturers for the same reason is good evidence for the soundness of the safeguarding measure.

It is reported that samples of the new viscose silk made by the Lilienfeldt process are being shown by Courtaulds, Ltd. It is claimed that the new viscose silk has a greater tensile strength when wet than the older variety, and also that it provides the means of obtaining the finer counts so much in demand at the moment.

Yorkshire

When comparing the turnovers of the individual months of a normal year with the corresponding ones of its immediate predecessor, given that it also was normal, one is struck by their similitude, despite decreased prices. There is a similarity between the turnovers of the September just completed and that of the September of last year, but whereas last year a tailing off was experienced towards the end of the month, this year the briskness with which the month opened was well maintained to the end and so a somewhat better value was reached. During September last year the price factor dropped from 2½ per cent. to 2 per cent. and prices of intermediates and particularly those of many dyestuffs have since steadily decreased, the latter by as much as 20 per cent. It would appear from these facts—turnovers slightly up and prices considerably down—that activity in our industry has markedly increased. Yorkshire makers are exporting more and, let it be said to the Leeds and Blackburn Chambers of Commerce, at prices very little in excess of those ruling in this country.

In this connection it should be explained that the Council of the Leeds Chamber of Commerce decided to support a resolution from Blackburn on the agenda for the annual meeting of the Associated Chambers of Commerce at Plymouth. It reads as follows:—"That this Association is of the opinion that the Dyestuffs (Import Regulation) Act is prejudicial to the interest of the textile industries, and is the cause of unemployment in those industries. The Association, therefore, calls upon the Government to repeal or amend the Act in such a way as to enable users to obtain dyestuffs at world prices."

Mr. C. W. Wade is reported in the daily press as having said, when moving that support be given to that resolution, that he could give examples of a number of cases in which dyewares were very considerably above what would be paid for them if the Act were not in existence. Yorkshire makers are asking how Mr. Wade became inspired with the knowledge of what dyestuff prices in Great Britain would be if it were not for the nurturing effect of the Act on an industry always striving to counter what assuredly would prove a dictation by the big foreign combines. They would be interested further to know whether Mr. Wade has observed over the past four years any substantial reduction in the prices of colours imported into but not made in Great Britain.

A letter was read from Mr. David Little, a past President of the Leeds Chamber of Commerce, in which he advocated the setting up of a permanent standing committee to deal with applications for safeguarding from all industries.

Employment in the worsted section of Yorkshire textiles continues slack and there is no improvement in the fine cloth trade at Bradford, Halifax, Huddersfield, and Keighley. In the Huddersfield and Colne valley district employment in heavy woollens is very quiet, and in Dewsbury and Batley it is described as bad. At Dewsbury few, if any, of the mills are running full time.

Scotland

SEPTEMBER, which was quiet during the first half, improved towards the end of the month with the onset of the autumn business. The summer was beginning to be felt as too long by the hosiery makers and knitters, but the cold snap at the end of the month showed an increased flow of inquiries and orders.

Dyers, bleachers, and finishers have remained fairly steady during the month, although the level of employment dropped slightly. Printers also have not been too busy; increased interest is being shown in block and spray methods in the search for novel effects. Dyestuffs and chemicals have lately tended to be quiet.

The linen manufacturers, especially in Ireland, are taking advantage of any opportunities which offer for the improvement of their trade, in which the last few years have been very difficult. On the technical side, for instance, increasing inquiries are being received for the dyeing of linen with fast vats, and many firms who have not gone in for these before are seriously considering doing so now.

There has been a slight set-back in the wool sections, as buyers have in some cases been holding off for lower prices; however, this will probably prove only temporary and the majority of manufacturers still have their mills going well.

The statutory meeting of Scottish Amalgamated Silks, Ltd., was held in Glasgow on October 3. Of the shareholders in Scottish Artificial Silks, Ltd., 93 per cent. have accepted the offer of the new company. Satisfactory reports of progress at the Bentham, Tongland and Argyll, and other works were given.

The information available of the attempt which is being made to establish an international bureau of standards for artificial silk has been welcomed by the trade. It promises to bring considerable reduction in the number of types, with consequent advantages to all concerned.

Colour Industry in Canada

THE production of inks, dyes and colours in Canada during 1927 amounted to $3,221,677, or 14 per cent. above the value reported for 1926. Of the 30 plants in the industry, 16 made printing inks and printers' rollers as their main products, 8 made writing inks, and 6 produced dyes and colours. The capital employed, including fixed assets and working capital, was $2,915,682.

Dyestuffs Monthly Supplement

Published in the second issue of "The Chemical Age" each month

Communications relating to editorial matter for the Dyestuffs Monthly Supplement should be addressed to the Editor, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4. Advertisement matter, subscriptions, etc., should be sent to the Manager. The Supplement is devoted to the interests of both manufacturers and users of dyestuffs, and contributions will be welcomed.

The Two New Browns

IN the last issue of our Monthly Dyestuffs Supplement, reference was made to the recent production and marketing for the first time in this country of the two important Indanthrene colours, Brown R and Brown G. We have now received from Scottish Dyes, Ltd., incorporated with Imperial Chemical Industries, Ltd., a pattern card of these new colours, which are being marketed under the name of Caledon Brown R and Caledon Brown G. They are shown applied in different strengths to mercerised unbleached cotton yarn and bleached cotton, to mercerised cotton and silk yarn, to mercerised cotton and viscose yarn, and as used for printing on mercerised cotton. The tones are extremely clear and strong in all the shades, the Brown R, as shown on mercerised cotton and viscose yarn, being particularly bright and clean. Scottish Dyes, Ltd., who have already done so much for the promotion of the British dyestuffs industry, are to be congratulated on this latest success in substituting British for continental productions.

Qualities Described

These browns are described as two of the most satisfactory colours in the vat dye range, as they combine all-round fastness with the best of dyeing properties. In the four most important particulars of fastness, both colours show the following standards: Excellence to light, chemic, washing and soda. They have excellent solubility and are level dyeing colours, which, although normally dyed cold, can be applied by either hot or cold methods, advantages which will be clear to the dyer and which make the colours particularly suitable for shading purposes. Both colours print without trouble, and are used in large quantities by vat printers. The standard potash method is the one recommended for printing. They are suitable for all types of machine dyeing, while their good levelling properties are of value for artificial silk dyeing and they also give excellent results on pure silk.

B.D.C. Colour Lakes

To the very important library of British colours of various kinds produced by the B.D.C., Imperial Chemical Industries, Ltd. have now issued a bulky volume dealing very thoroughly with the wide range of B.D.C. colour lakes. As is generally known, colour lakes are complex compounds, either insoluble or almost insoluble in water, which are obtained by precipitating dyestuffs from their solution in water on to so-called bases or substrata by the addition of certain metallic salts, tannic acid, etc. In addition, simple mixtures of insoluble azo colours or insoluble vat colours with the various bases are also described as lakes by the colour lake manufacturer and user. This volume gives a very clear chemical account of the bases used in connection with colour lakes as well as of the precipitating agents, the dyestuffs suitable for lake manufacture and other technical particulars.

A Range of 73 Colours

This volume deals with no fewer than 73 distinct colours or shades of colour, including acid dyestuffs, dyestuffs of the Eosine class, basic dyestuffs, insoluble azo dyestuffs with no lake-forming properties, and insoluble or partially soluble azo dyestuffs which possess lake-forming properties. The fastness properties of these dyes are very conveniently set out in a set of fastness tables, which have been very carefully prepared, and are recommended as a reliable guide. At the same time, it is added, as trade requirements are extremely varied, and it is impossible in general tables of this class to take into account every possible factor that might effect the result, it is well in all special cases that users should make their own fastness tests. In addition to the chemical information about the dyes, a print is shown of each colour, illustrating the exact effects produced by the methods of preparation laid down, and indicating the extremely wide range of colours which are now available to the colour lake user.

New B.D.C. Colours

In addition to the dyestuffs already mentioned, we have received from Imperial Chemical Industries, Ltd., three new B.D.C. colours, namely, Chlorazol Orange Brown R, Toluylene Orange G, and Dispersol Diazo Black A Paste. The two orange colours are additions to the existing range of B.D.C. direct cotton colours.

Chlorazol Orange Brown R is recommended for the dyeing of cotton pieces or yarns, either in direct shades or aftertreated with copper sulphate. The latter process gives orange brown shades of good light fastness. This colour is described as particularly suitable for dyeing wool-cotton and silk-cotton unions, while its property of giving fairly good even dyeings on viscose silk of irregular quality makes it of interest to dyers of this material. The effects, as shown on cotton pieces, and cotton wool union, are bright and satisfying.

Toluylene Orange G is applicable either in direct shades or coupled with diazotised paranitraniline, the former giving as the patterns show, orange brown shades, the latter full reddish brown shades of very good washing fastness.

Dispersol Diazo Black A Paste is an addition to the B.D.C. range of colours for cellulose acetate silk. It gives a full bluish black shade by diazotisation and development on the fibre with β-oxynaphthoic acid. It is applicable to all types of cellulose acetate silk, and to union materials containing cellulose acetate silk. The effect is extremely good as shown on cellulose acetate silk yarn and cellulose acetate silk piece.

Action of Metals on Dyestuffs

Elsewhere in this supplement is published an important article by Mr. G. C. Grundy on the action of metals on dyestuffs. Mr. Grundy has accumulated a vast quantity of data on the subject, which has been published by the Clayton Aniline Co. in the form of a tabular synopsis on the action of metals on dyestuffs. The members of each class of colours (acid, cloth fast, Neolan, chrome fast, direct and chlorantine fast) are grouped together, and the tables show the manner of their dyeing in presence of various metals. For example, under acid colours, the first heading is Quinoline Yellow, which dyes normally in the presence of enamel, nickel, lead, and brass; not quite so normally in the presence of Firth stainless and Staybrite, Dyebrite, and Silverite; duller in the presence of Monel metal; redder and duller in the presence of phosphor bronze; and most abnormally of all in the presence of cast iron, wrought iron, and copper.

The tables fill altogether 17 pages, and their value to all those concerned with the dyeing industry should be simply enormous. The Clayton Aniline Co. is to be congratulated on its enterprise in this matter.

The Claims of "Haveg"

IT is well-known that the machines and vessels used in dyehouses and finishing works are subjected to severe tests, and where the material is poor the cost of renewal is heavy. In addition, it is important that the goods being dyed should not be in contact with metal parts liable to induce the formation of rust or of metallic salts which may stain or rot the goods. From Trost Brothers, 104, Victoria Street, London, we have received particulars of the comparatively new material known as "Haveg." It is said to be unaffected by non-oxidising inorganic and organic acids and other reagents. It stands a temperature of about 130°C. In spite of its lightness (its specific gravity is 1·6) it withstands a pressure of about 5·2 tons per square inch and a bending strain of about 2·8 tons. It is composed of Bakelite, the well-known artificial resin, mixed with asbestos fibres. From the list given of acids by which it is unaffected, it appears to have considerable possibilities wherever acid or neutral dyebaths, or dyebaths made alkaline with soda ash, are employed. A warning is given, however, that it cannot be used in dyeing vegetable fibres or in dyebaths made alkaline with caustic soda.

The Dyeing of Fruit Pulp

IN the annual report of Dr. H. H. Bagnall, city analyst for Salford, reference is made to the use of colours in food. One sample contained sulphur dioxide, and the jam was dyed with an aniline dye. There was hardly any whole fruit in it at all, and it was probably made from preserved pulped fruit, possibly two or three years old. The dye was obviously used, therefore, to restore the colour. Besides this and other instances of dyeing, there were several cases of firms making misleading statements on their labels. This leads Dr. Bagnall to suggest that all manufacturers should be forced to show on a label what ingredients are used and in what proportion. Speaking generally, Dr. Bagnall says that the adulteration of foodstuffs is no longer the crude, unscientific business it once was; it is conducted on scientific lines, and as much time and ingenuity are spent on it as the analyst is often compelled to use to detect it.

Sixteen Kuhlmann Intermediates

ACCORDING to a report issued by the U.S.A. Department of Commerce, 16 new dye intermediates were perfected during 1927 at the Oissel and Villers-Saint-Paul plants of Etablissements Kuhlmann, and the company introduced 85 new kinds of dyestuffs on the market, representing about 40 new types. The company concentrated chiefly on vat dyes of the Solanthrene series, and on dyestuffs for use with acetate silk and furs. The total production of dyestuffs amounted to 8,000 metric tons (as compared with 6,900 tons in 1926), of which 3,500 tons were indigo dye (20 per cent. paste), as compared with 4,200 tons in 1926; 2,500 tons of nitrogenous dyes (3,300 tons in 1926), and 2,000 tons of alizarine and other dyes (2,400 tons in 1926). Etablissements Kuhlmann produces more than half the entire French production, followed by the Colorants de Saint-Denis and Saint-Clair du Rhone.

In 1913 France imported from Germany half the dyestuffs she used. In 1921 20 per cent. of the consumption was imported (1,440 tons out of 7,000 tons); in 1923 11 per cent. (1,400 tons out of 11,500 tons), and in 1927 8 per cent. (1,570 tons out of 19,500 tons). The French industry now produces one-fourth as much as Germany, and the recent sales agreement between the I.G. Farbenindustrie and the French producers gives France the right to maintain the existing production ratio in its expansion activities.

The Soviet Aniline Trust

A DELEGATION from the Soviet Anilintrest (Aniline Trust), which controls the production of aniline dyes in the U.S.S.R., has arrived in the United States for the purpose of visiting chemical plants and looking over the American equipment market. The delegation is headed by E. L. Brodoff, general manager of the Derbenoff Works, Moscow. The commission consists of P. A. Konburov, director of the Butirsky plant; G. A. Bonvetch, chief engineer, and Dr. Celia A. Voskevitch, sanitary inspector of the Anilintrest. Their itinerary, which will cover a stay in the United States of about three months, will include Philadelphia, Boston, Chicago, Detroit and other large centres of the chemical industry. The commission will be accompanied part of the time by Professor Rodionov, chemical director, and Professor Vorozhzev, director of research of the Aniltrest, who went to the United States to consult with Professor Harry D. Gibbs, of Washington.

U.S.A. Dyestuff Exports

EXPORTS of dyes from the United States during July, 1928, amounted to 3,817,095 lbs., valued at $779,530, which is more than double the exports for the same month a year ago of 1,525,751 lbs., valued at $331,387, according to preliminary figures of the Chemical Division, Department of Commerce. The total for the first seven months of 1928 comes to 15,000,000 lbs., worth $3,500,000, a 10 per cent. increase in quantity and a 16 per cent. increase in value over the same period last year. China's purchases represented two-thirds of the total quantity shipped, or 10,259,765 lbs., valued at $1,346,588. The country to take the next largest quantity was Canada, which imported 1,573,867 lbs., valued at $594,860, but Japan's imports, though smaller in quantity, 868,588 lbs., were higher in value, $671,880. British India took 881,660 lbs., valued at $385,104.

The Fast Colour Label

THE habit of advertising the merits of fast colours on fabrics continues to grow in America. One of the chief features of the Du Pont Products exhibit at Atlantic City was a display of cotton and artificial silk dress materials dyed with the firm's vat dyestuffs. The goods all bore the "Nafal Tested Fast Colours" tag, attesting the fact that samples had been tested for fastness by the Pease Laboratories, of New York City. Each of the tags showed the laboratory test number, stating: "A sample from the particular dyeing of which the goods bearing this label are a part has been tested by the Pease Laboratories and conforms to the standards for fast colours established by the National Association of Finishers of Cotton Fabrics and the standard washroom practice as published by the Laundryowners' Association. A definition of these standards has been filed with the Bureau of Standards, U.S. Department of Commerce, and the Federal Trade Commission, Washington, D.C." The label is protected by copyright.

Dyestuff Licences for October

THE following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during October has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee:

The total number of applications received during the month was 773, of which 606 were from merchants or importers. To these should be added 15 cases outstanding on September 29, making a total for the month of 788. These were dealt with as follows:—Granted, 713 (of which 696 were dealt with within seven days of receipt); referred to British makers of similar products, 62 (of which 50 were dealt with within seven days of receipt); outstanding on October 31, 15. Of the total of 788 applications received, 746 or 95 per cent. were dealt with within seven days of receipt.

Colour Chemistry and Dyeing from the Academic View

By F. M. Rowe, D Sc.

Below we publish an address which was given recently to the Society of Dyers and Colourists by Professor F. M. Rowe, head of the Department of Tinctorial Chemistry of Leeds University.

PROFESSOR ROWE said that when he was invited to speak, it seemed to him that he might say something about the industry in which he was engaged and its products of trained students, for the success or failure of the teaching of colour chemistry and dyeing was a matter which intimately concerned all of those who were interested in textiles, dyes and dyeing.

Year by year, increased prominence was very properly given in both academic and industrial circles to the importance of scientific research, so that it was now rather easy to overlook the fact that one of the greatest services which could be rendered to the community by the science departments, and especially the applied science departments, of universities and technical colleges, was still the provision of well-trained recruits for industry.

The question of what was the most effective method of training recruits for industry, and especially for the industries in which all of them there were interested, still appeared to be debatable to some extent, and that was why he was prepared to welcome that opportunity of stating his own views on the subject. Any of his colleagues from other educational institutions who were present would forgive him for taking his own department at Leeds University as the basis of his remarks, for, naturally, he was best fitted to speak of what occurred there, but he hoped that they would say similar things if they were speaking about the work which they were so splendidly carrying out in, for example, Bradford Technical College, the Manchester College of Technology, Huddersfield Technical College, and elsewhere in this country.

Colour Chemistry at Leeds University

Looking back on the history of the forty-eight years of its existence, the Colour Chemistry and Dyeing Department at Leeds had been extraordinarily fortunate in having had such a sequence of men as its professors as his distinguished predecessors J. J. Hummel, A. G. Green, and A. G. Perkin. It was clear that each had pursued the same definite educational policy in the steady development of the type of courses which were now provided. They all from the outset had resolutely refused to provide a purely mechanical, vocational training in the department; but, often in the face of considerable opposition, had striven to provide a sound and broad education on an increasingly scientific basis, in preparation for—and he hoped they would note those words "in preparation for"—a career in any branch of industry in which the chemistry of colouring matters, of textile fibres and of the processes to which they were submitted, played an important part. That was the policy which he in his turn had adopted.

He thought they must agree that it was extremely important that the graduates of an applied science department in a university must be required to attain at least as high a standard of general scientific attainment as graduates of the pure science departments. If anything, a somewhat higher standard was actually desirable.

Two Points of View

The training of a student in colour chemistry and dyeing was open to criticism from two extreme points of view. On the one hand, he still sometimes met an employer who would prefer to be able to engage a student who had received the maximum possible amount of training directly connected with the prospective employer's special branch of business, even at the expense of some of the fundamentals, for which he perceived no immediate application. Fortunately, this narrow and unenlightened point of view was becoming increasingly rare.

If there were such an employer there present, he would ask him whether he was prepared to admit that the nature of his business would always remain as it was to-day, and that he did not desire to progress, because unless he was prepared to make that admission, the broader and less specialised the training which the prospective recruit had received, the better for the success of his business.

When a student entered for a course in colour chemistry and dyeing, he seldom knew definitely whether he would ultimately obtain a position in such widely different branches of industry as the manufacture of intermediates and dyes or of lake pigments, or the distillation of tar, or the manufacture of artificial silk or other cellulose products, or calico printing, or the various branches of dyeing, including garment dyeing and cleaning.

Even if the student, on entering his course, did know in which of the industries he would be employed, it would be most unwise to allow that to limit the breadth of his training. Sometimes students with little or no preliminary knowledge of chemistry and physics actually wished to learn to dye just one kind of textile fibre to the exclusion of all others, or even went further and defined the stage of manufacture at which they wished to learn to dye that particular fibre. Putting the cart before the horse in that manner had never received any encouragement from him, and never would.

Prejudice Against Technological Training

On the other hand, there were some critics who still felt that the inclusion of technological departments in educational establishments was a retrograde step. To some, the very name of applied chemistry as a teaching subject was anathema, and from time to time they fulminated against premature specialisation and so forth, usually with little or no inquiry into the facts. Actually, the training of a student of colour chemistry and dyeing should be, and was, superimposed upon the normal preliminary training in the pure sciences to which candidates for degrees in pure science were subjected, and was merely a continuation of the pure sciences from the point of view of certain industries. Some of his most successful students had made little or no progress until they began to study chemistry as applied to the industries, because they required the added stimulus of economic and industrial factors to impress upon them the essential importance of the strictest accuracy in their work, and economy of time and materials.

The chief aim of a teacher of colour chemistry and dyeing should be the production of a scientifically-trained graduate with a reasonable knowledge of dyes, textile fibres and the processes to which they were submitted. Such a graduate was then capable of investigating the problems which arose, whether they were labelled as belonging to the domain of pure or applied science.

Co-operation with Other Sciences

Colour chemistry and dyeing could be taught properly in an isolated building, for successful training in those subjects was only possible by close co-operation with the pure chemistry, physics, mathematics, engineering and textile industries departments of a large educational establishment. Colour chemistry and dyeing could not be considered separately. It was as necessary for a modern dyer to possess knowledge of the chemistry of the dyes which he used, as it was for a colour maker to be familiar with the uses to which dyes were put. An intimate acquaintance with the structural organic chemistry of synthetic dyes was essential to a colour chemist who hoped to be employed in the dye-making industry, and required a thorough knowledge of pure chemistry before specialising in that direction.

Such advanced knowledge of colour chemistry was useful to a dyer, but he agreed that it was not essential, and it certainly could not be acquired in a three years' full-time day course. It was equally necessary, however, for a dyer to acquire at the outset a sound fundamental knowledge of pure chemistry, physics and mathematics, on which his art was based, while the subsequent study of colouring matters could be limited to the acquisition of a thorough knowledge of their properties and behaviour in dyeing, with but a general knowledge of their chemical structure and mode of manufacture.

At Leeds they met the requirements of these two classes of students by a course qualifying for the degree of B.Sc. with Honours in Colour Chemistry and Dyeing in four years

after matriculation, and a course qualifying for the ordinary degree of B.Sc. in Dyeing in three years after matriculation. Unmatriculated students could qualify for University Diplomas by taking courses on somewhat similar lines and of the same duration as the corresponding degree courses, but the stage of progress had now definitely been reached when all students who could do so were much better advised to matriculate and qualify for degrees.

Nature of Training

In either of the above courses, the first year was spent entirely outside the Colour Chemistry and Dyeing Department in attending lectures and laboratory classes in pure chemistry and physics, and lectures in mathematics. Two-thirds of the time in the second year was spent in attending lectures and laboratory work in pure inorganic and organic chemistry, and the remaining third was spent in the experimental dyeing laboratory.

In the third year some time was spent outside the Department in attending lectures and laboratory classes in pure physical chemistry and lectures on engineering, but the major portion of the time was spent within the Department attending lectures on the chemical technology of textile fibres, the chemistry and technology of dyeing, and introductory lectures on the chemistry of intermediates and dyes, with practical work on dyeing, calico printing and cloth finishing, including analysis of typical dyewares, etc., in the laboratories and dyehouse. The fourth year of the Honours course was spent entirely within the Department, and was devoted to lectures on synthetic and natural colouring matters, and to practical colour chemistry. All candidates for degrees or diplomas must acquire a satisfactory reading knowledge of French and German in order to be able to consult the foreign literature of subject.

Courses for shorter periods were also arranged to suit the individual requirements of students who wished to receive special training in colour chemistry and dyeing, provided that they had a satisfactory previous training in the pure sciences.

Professor Rowe said that details of the equipment of the Department or of the actual work on colour chemistry and dyeing carried out by the students could be found in a prospectus, but one point called for comment.

The Machinery Side of Dyeing

Their practical dyehouse at Leeds University was now equipped with typical modern machinery for processing wool, cotton and artificial silks in their various stages of manufacture. In addition to dyeing material to the requirements of the adjacent textile industries department, ample other textile materials were provided for experimental purposes, so that students could acquire as much varied practical experience on a semi-large scale as they wished. That was supplemented by the kindness of a number of firms who were good enough to help students to gain additional practical experience by allowing them to work in their factories during the University vacations. They now gained also a brief experience in the tanning and dyeing of leather in the adjacent leather industries department.

Post-Graduate Training

Students of the Department who had obtained the degree of B.Sc. with Honours, as well as graduates of other approved universities, could carry out research in colour chemistry or dyeing, etc., in the three research laboratories at Leeds University, as candidates by thesis for the degree of M.Sc. in one further year or the degree of Ph.D. in two further years.

Such post-graduate training in research was of inestimable benefit in developing a student's capabilities, out of all proportion to the extra investment of time and money involved. It must be remembered, and especially must it be remembered by the student himself, that prior to graduation his practical work had consisted mainly in acquiring accuracy and manipulative skill by carrying out various experiments, which were known to succeed and for which exact details of procedure were supplied. He had never ventured into the unknown, and had yet to discover whether he possessed or could develop the faculty for surmounting difficulties. A student who had passed through his course with flying colours, graduated with First Class Honours and possibly been awarded a medal as well, ran a serious risk of feeling self-satisfied and that he had little left to learn. That state of mind, when it existed, disappeared entirely, however, after the first few months of research work, and the inevitable depression which set in when the truth dawned as to how little any one of us yet knew must be removed by careful guidance. After passing through that period, ingenuity and initiative developed rapidly, and he was sometimes amazed at the quality and quantity of the work which some research students turned out.

Subsequent Careers of Students

Professor Rowe said that his academic view of colour chemistry and dyeing would be incomplete if he did not conclude by saying something of what became of students after they had satisfactorily completed their courses, for it was by the subsequent careers of their students that the success or failure of their work must be judged. The placing of these students was greatly facilitated by the fact that many firms now realised that they required to know something more of a prospective recruit than that he had passed through a certain training and obtained a certain degree. They wanted an opinion as to his personality, disposition, temperament, and promise, based on personal observation and intimate contact both in and outside College hours over a long period, and they were wise enough to consult the teachers concerned when vacancies occurred on their staffs.

In the case of his own department, this demand for their students, especially for those with post-graduate training, had recently considerably exceeded the supply available, and he had been forced to tell prospective employers that there would be no more ready for employment until next summer.

Of the students who completed courses in the Colour Chemistry and Dyeing Department at Leeds University during the period 1919–1928, he had details of the work which 183 of them left the Department to take up :—

Sixty-nine became dyers and dyers' chemists in every branch of the industry ; eight chemists to dyers and cleaners ; eight calico printing chemists ; 17 dyeing chemists and travelling experts to dye makers ; 31 works chemists and research chemists to intermediate products and dye makers ; two research chemists to pigment makers ; 20 chemists to artificial silk manufacturers ; six textile chemists and research chemists for textile fibres ; 12 teachers ; one a factory inspector ; and nine research chemists in other industries.

When it was remembered that they all attended substantially similar courses, he thought there was something to be said for the thorough and fundamental scientific and technical training which he had outlined.

He had yet to meet a student from any educational establishment in this country where colour chemistry and dyeing were taught in full-time day courses, who regretted the time spent in those subjects, if he was trained sufficiently broadly and satisfactorily completed the courses. Nor had he ever met a reasonable employer, who had tried one of these students as a recruit and had realised that he required a short time in which to feel his feet in a works, who had ever regretted employing him. On the contrary, having tried one of these students, no matter whether he was trained at Bradford, Manchester, Leeds or elsewhere, sooner or later the employer would ask for another of similar type.

U.S.A. Package Dyestuff Exports

EXPORTS of package dyes for household use from the United States amounted to 202,152 lb. during the first eight months of 1928, valued at $146,633, according to the Chemical Division, Department of Commerce. This is the first year enumerated in export statistics.

Japan was the heaviest purchaser, buying 36,762 lb., valued at $53,783. Canada ranked next with 72,980 lb., valued at $23,137. Mexico and Argentina bought quantities worth $11,912 and $6,295 respectively, and shipments were made to 43 other countries.

Consul H. M. Wolcott, of Caracas, states that the use of package dyes in Venezuela is on the increase. This has not as yet been reflected in American export trade, which was valued at only $4,583 during the eight months' period, largely because European package dyes are available at lower prices, and the average consumer must be educated to economic advantages before he is willing to pay the higher price charged for the American product.

The Use of Various Metals and Alloys for Dyeing Machines

Some Notes on Their Suitability

A very important piece of work has been carried out by Mr. J. C. Grundy, who has determined the actions of various metals used in the manufacture of dyeing machines on various classes of dyestuffs. The results have been published by the Clayton Aniline Co.

A SURVEY of modern literature indicates that there have been no comparative tests made of modern metals and alloys demonstrating their advantage over one another or over the older metals, such as iron, copper, etc. in their resistance to dyestuffs, although much literature is available dealing with the non-corrodible qualities of the various metals.

From the point of view of freedom from reaction with dyestuffs and the reagents used in the application of the latter, the following metals have been tested :—Cast iron, wrought iron, copper, nickel, Monel metal, lead, Firth stainless steel, Firth Staybrite, Dyebrite, Silverite, phosphor bronze, and brass.

Analysis of the Metals Investigated

Commercially pure samples of nickel, lead and copper were used, the composition of Firth stainless steel and Firth Staybrite being kindly supplied by the Brown-Firth Research Laboratories. The analyses of the various metals used were as follows :—

FIRTH STAINLESS STEEL.

Carbon	0·35 per cent.
Manganese	0·25 ,, ,,
Silicon	0·25 ,, ,,
Sulphur	0·01 ,, ,,
Phosphorous	0·015 ,, ,,
Nickel	traces ,, ,,
Chromium	13·50 ,, ,,

FIRTH STAYBRITE.

Carbon	0·35 per cent.
Manganese	0·25 ,, ,,
Silicon	0·30 ,, ,,
Sulphur	0·010 ,, ,,
Phosphorous	0·015 ,, ,,
Nickel	8·0 ,, ,,
Chromium	18·0 ,, ,,

DYEBRITE AND SILVERITE.

Apparently similar to Firth Staybrite.

MONEL.

The composition, kindly supplied by Monel-Weir, Ltd., is as follows :—

Nickel	67 per cent.
Copper	28 ,, ,,
Other Metals	5 ,, ,,

PHOSPHOR BRONZE.

Copper	85 per cent.
Tin	5 ,, ,,
Phosphorous	10 ,, ,,

Copper	95 per cent.
Phosphorised Tin	5 ,, ,,

BRASS.

Copper	70·30 per cent.
Zinc	29·30 ,, ,,
Tin	0·17 ,, ,,
Lead	0·28 ,, ,,

Groups of Colours Tested

The following groups of colours have been tested :—

(1) *Acid Colours*, applied with the addition of 10 per cent. Glauber's salt and 3 per cent. acetic acid, or 3 per cent. sulphuric acid, depending upon the level dyeing properties of the colour, at the boil for 1 hour.

(2) *Cloth Fast Colours*, applied with the addition of, 10 per cent. Glauber's salt and 3 per cent. ammonium acetate, for 1 hour at the gentle boil.

(3) *Neolan Colours*, applied with the addition of 10 per cent. Glauber's salt and 7 per cent. sulphuric acid at the boil for 1½ hours.

(4) *Chrome Fast Colours*, applied with either all organic acid and afterchromed with the requisite quantity of bichromate of soda, or with part organic acid and part mineral acid, afterchroming with bichromate of soda, depending upon the colour in question.

(5) *Direct Colours*, applied with the addition of 20 per cent. Glauber's salt or with 2 per cent. soda, depending upon the type of colour, for 1 hour at 95° C.

(6) *Chlorantine Fast Colours*, applied in a similar manner to the direct colours. This series is mainly distinguished by the fastness properties to light.

(7) *Direct Colours of the Diazo Fast and Rosanthrene Type.* These colours were applied as ordinary direct colours, diazotised with sodium nitrite and sulphuric acid and coupled with a suitable developer, for example, beta-naphthol, metatoluylenediamine, etc.

(8) *Basic Colours*, applied with the addition of a small quantity of acetic acid cold, continuing the dyeing operation at 60° C.

(9) *Sulphur Colours*, applied with the addition of sodium sulphide in quantities varying from equal weights to three times the weight of sodium sulphide, at temperatures varying between 50° and 80° C.

(10) *Vat Colours*, applied from a caustic alkaline hydrosulphite bath, the types of colours being indigoid and anthraquinone derivatives.

(11) *Azoic Colours*, for example : Paranitraniline, metanitraniline, dianisidine, etc.

In each case the padding was carried out on an ordinary padding mangle and the diazotising and coupling processes were carried out in the presence of varying metals.

In a pamphlet issued by the Clayton Aniline Co., entitled "The Effects of Metals on Dyestuffs," the effect of dyeing each of a large number of dyestuffs in each class from each metal is described. Owing to the large number of results, it is impossible to give here more than a summary.

Results for Acid Colours

Generally speaking, the whole of the acid colours are sensitive to cast iron, wrought iron, copper, Firth stainless steel and phosphor bronze, but nickel, Monel metal, Staybrite, Dyebrite, Silverite and brass gave good results. In the Cloth Fast series the colours are equally susceptible to cast iron and wrought iron, but yield fairly satisfactory results when applied in a copper bath, and good results with all the other metals with the exception of lead, in which case remarkable results were obtained ; this metal would be termed unsuitable for the dyeing of this type of colour.

In spite of the large quantity of acid used in the dyeing operation, the Neolan colours are less susceptible to metals than any other group of dyestuffs applied from an acid dyebath, this being, no doubt, due to the fact that the colours are already metallic salts.

Chrome Fast colours, applied by the afterchrome process, are exceedingly susceptible to various metals, particularly iron, nickel, lead, copper and to a lesser extent Monel metal ; alloys of the Staybrite type yield very good results. The results for the Chrome Fast series applied by the afterchrome process do not hold good for the dyeings applied either on a chrome mordant or by the metachrome process. Generally speaking, colours applied by the metachrome process and on a chrome mordant are not as susceptible to extreme changes as is the case when applied by the afterchrome process.

Direct Colours

Direct colours are not appreciably effected by metals other than in the case of wrought iron and cast iron, but there are occasional exceptions. Copper has an appreciable effect upon several colours, for example, Direct Green B is changed much browner when applied in machines made of this metal. The remarks just made in connection with the Direct colour group as a whole will also bear good for the Chlorantine Fast series.

With regard to group No. 7, Direct colours of the Diazo Fast and Rosanthrene type, all the metals tested gave good results with the exception of cast iron and wrought iron, which gave slightly duller shades.

Basic, Sulphur, Vat and Azoic Colours

With Basic colours, all the metals gave good results with the exception of cast iron and wrought iron, which gave somewhat duller shades, and lead, which gave weaker shades. With Sulphur colours, the metals containing copper are considerably effected by the action of sodium sulphide and

would not be suitable machines for the dyeing of this class of colour. The other metals gave good results. As regards Vat colours, all the metals gave good results with both the indigoid and anthraquinone type of colours. For Azoic colours, all the metals gave good results with the exception of cast iron and wrought iron, which yield slightly duller tones.

Effects on the Metals Themselves

Investigations have also been made regarding the effect on the metals themselves when used for the various dyeing operations. The tests were carried out as follows:—Boiling in 0·2 per cent. sulphuric acid solution for 8 hours; treatment in 0·2 per cent. sodium sulphide crystals solution at 90° C. for 8 hours; treatment in 4 parts caustic soda 66° Tw. and 100 parts water at 80° C. for 8 hours; treatment in 4 parts caustic soda 66° Tw., 2 parts hydrosulphite, and 100 parts water at 80° C. for 8 hours; treatment in 4° Tw. chemick, cold, for 8 hours; treatment in 0·2 per cent. solution sulphuric acid containing 0·1 per cent. sodium nitrite, cold, for 8 hours.

The results of the tests are given in the table below.

Results of Tests Made Showing Loss in Weight and Reaction of Various Metals Under Different Conditions

LOSS IN GRAMMES PER SQUARE METRE AFTER 8 HOURS IMMERSION IN SOLUTION.

Metal.	Boiling in 0·2% Sulphuric Acid Solution for 8 Hours.	Treatment in 0·2% Solution of Sodium Sulphide Crystals at 90° C. for 8 Hours.	Treatment in 4 Pts. Caustic Soda 66° Tw. 100 Pts. Water at 80° C. for 8 Hours.	Treatment in 4 Pts. Caustic Soda 66° Tw. 2 Pts. Hydrosulphite 100 Pts. Water at 80° C. for 8 Hours.	Treatment in 4° Tw. Chemick Cold for 8 Hours.	Treatment in 0·2% Solution Sulphuric Acid 0·1% Solution Sodium Nitrite Cold for 8 Hours.
Cast Iron	710 Corrosion taken place	Nil Appearance blacker	Nil Corrosion taken place	Nil Appearance blacker	500 Obvious corrosion	88 Little change
Wrought Iron ..	430 Corrosion taken place	Nil Appearance blacker	Nil Corrosion taken place	Nil Appearance blacker	100 Obvious corrosion	60 Little change
Copper	30 Appearance duller	Nil Appearance blacker	Nil Little change	Nil No change	Nil No change	18 Little change
Nickel	6 No change	Nil Appearance blacker	Nil No change	Nil Appearance blacker	30 Corrosion taken place	12 Little duller
Monel	10 No change	Nil Appearance blacker	Nil No change	Nil Somewhat blacker	20 Slight corrosion	12 Little duller
Lead	Nil Coated with Lead Sulphate	Nil Brighter	21 No change	Nil No change	Nil No change	10 Coated with Lead Oxide
Firth Stainless Steel	380 Appearance duller	Nil Slightly blacker	Nil No change	Nil No change	5 No change	Nil No change
Firth Staybrite	Nil No change	Nil No change	Nil No change	Nil No change	Nil No change	Nil No change
Dyebrite	Nil No change	Nil No change	Nil No change	Nil No change	Nil No change	Nil No change
Silverite	Nil No change	Nil No change	Nil No change	Nil No change	Nil No change	Nil No change
Phosphor Bronze	20 Duller	Nil Appearance blacker	5 Little change	Nil Appearance blacker	Nil No change	Nil Little change
Brass	5 No change	Nil No change	14 No change	Nil No change	Nil No change	24 No change

The Market for Dyes in India

Consul W. Keblinger, Bombay, in a special circular of the U.S.A. Department of Commerce, describes India as an important market for aniline dyes, and with the increasing purchasing power of the people the business is certain to show large gains from year to year. A large portion of all of the aniline dyes imported into India comes through the port of Bombay, which is the chief distributing centre for the trade. Before the war Germany had almost a monopoly of the trade, but following the efforts of Great Britain, France, Belgium, and the United States to create aniline dye industries to replace the German supply stopped by the war, India was forced to depend on these countries for its dyes. This condition continued for some time after the conclusion of the war, but once Germany re-entered the market it made giant strides to recover its former trade and has each year increased its percentage of the whole business.

The total imports from Germany for 1927, which includes those coming from the Netherlands, represent practically 70 per cent. of the total trade, with the United Kingdom second with 9.6 per cent. and the United States third with 8.1 per cent. These total figures, however, include alizarine, which represents practically the total imports from the United Kingdom. If the aniline figures are taken separately Germany again leads with approximately 70 per cent. (including imports from Netherlands), with the United States second with 11.1 per cent. and the United Kingdom falling behind Italy and Switzerland. Actual imports shown as coming from Italy may be considered as having originated in Switzerland.

The alizarine business is done almost wholly by Germany and Great Britain, with Germany taking approximately 70 per cent., the United Kingdom 23.9 per cent. and the United States and Switzerland taking negligible amounts.

The total annual consumption of dyes in India, based on the import figures running over a period of years, may be said to be approximately 15,000,000 lb.

There are two separate and distinct markets for aniline dyes in India; that is, the bazaar market and the mill trade. Aniline dyes are sold in every town and village throughout India, Burma, and Ceylon. They are marketed in 1 and ½ lb. tins, although some sales are made in the larger markets in lots of 28, 56, and 112 lb. or even larger quantities. Such sales, however, are usually confined to local dye houses of some consequence.

There are certain well recognised colour selling districts, the most important of which are Adoni, Agra, Ahmedabad, Amritsar, Bangalore, Benares, Bombay, Karachi, Madras, Madura, Mangalore, Multan, Nagpur, Patna, Peshawar, Salem, Sholapur, Tinnevelly, and Tirapur. To these centres come the purchasers from the smaller centres, who in turn sell to the outlying villages. The smallest dealer of all will sell out of open tins in extremely small quantities, charging perhaps an anna or two for a spoonful of dye. Dyeing is done for the most part by local dyers in each village.

Dyes and Their Application: Recent Technical Progress

By L. J. Hooley

In the Dyestuffs Monthly Supplement for June, the developed azo dyes were considered from the synthetic standpoint, and the constitution of some new azo components described. In the following, the same class of products will be dealt with from the application side.

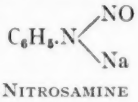
Stable Diazo Components for Development Dyes

With the introduction of the first of the development colours, Para Red, and its subsequent popularity, attempts were soon made to simplify matters for the dyer by the introduction of preparations for the elimination of the diazotisation stage, so that the dyer after padding with beta-naphthol would only require to dissolve the selected preparation in water and then pass through his padded material. Among the artificial preparations made up for this purpose were concentrated solutions or pastes of the diazo body, nitrosamine compounds, mixtures of the diazo body with aryl sulphonic acids, zinc chloride double compounds, and powders obtained by treating the concentrated diazo pastes with sodium sulphate. These appeared on the market as Nitrosamine Red, Azophor Red, Nitrazol Red, Nitrosamine Pink, etc. Most of this work was done between 1893 and 1897.

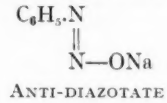
With the increasing importance of development colours at the present time, there has been a revival in the preparation of stable diazo bodies and a considerable number of new patents have recently appeared. These, although similar in general principles to the older ones, present many interesting features and new developments, and some very satisfactory products have been placed on the market.

Nitrosamines

The nitrosamines, already referrred to, represent one of the most interesting devices for stabilisation. They were discovered by Griess, who obtained them by treating the diazo chlorides with strong alkali. As to their constitution, this forms part of the larger and unsettled question of the structure of the diazo bodies in general. It will be sufficient here to give the two alternative formulae of Bamberger and Hantzsch.



Nitrosamine



Anti-diazotate

Hantzsch does not represent them as nitrosamines, but as anti-diazotates. Their essential feature is that they are stable and do not couple, but are readily converted to the coupling form by treatment with acid.

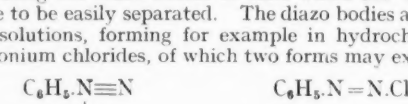
The nitrosamines, however, do not represent the most suitable of the various diazo preparations which have been suggested. Generally speaking they are of less interest than the diazo salts, referred to in greater detail below.

Recently Bucherer has introduced an improvement in the use of the nitrosamines, as he has found that they can be made to couple in faintly alkaline solution if the temperature be raised to about 90–100° C. (B.P. 249, 562). The method has advantages for printing; the strongly alkaline nitrosamine paste is nearly neutralised with, for example, calcium chloride, and the print developed by steaming.

With regard to the zinc chloride double salts already mentioned, these were introduced in the first instance for diazotised aminoazo compounds, but they have been recently extended to diazotised amino compounds in general (B.P. 238,676).

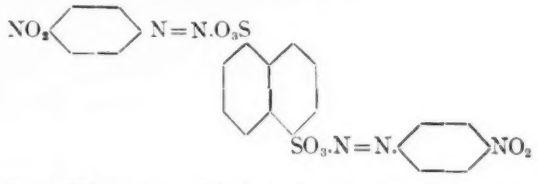
Stable Diazo Salts

One of the most general of the methods is that consisting in converting the diazo bodies to salts which are sufficiently insoluble to be easily separated. The diazo bodies act as bases in acid solutions, forming for example in hydrochloric acid the diazonium chlorides, of which two forms may exist.



These compounds are very soluble, but if instead of the mineral acid an aromatic sulphonic acid be used, the resulting salt is much less soluble. It is not necessary to use the free aromatic sulphonic acid in preparing these diazo salts; the sodium salt can be used in strong mineral acid solution.

Among the compounds which may be used are naphthalene-1·5-disulphonic-, -trisulphonic-, -tetrasulphonic-, para-chlorbenzenesulphonic-, paratoluenesulphonic-, and benzyl-naphalene-sulphonic acids, the first being widely mentioned. (B.P. 265,985, 269,212, 275,245, I.G.F.A-G.)



Other acids can be used if desired, and, generally speaking, if the diazo salts are sufficiently insoluble to be precipitated in this way, they are also found to be sufficiently dry to be stored. In the case of a polybasic acid, one or more of the sulphonic acid groups may combine with the diazo body, the remaining groups in the former case either remaining free or being combined with the metal.

This method of salt formation is hardly suitable for diazo bodies which themselves contain sulphonic acid groups, and here the nitrosamines are of advantage. The presence of nitro groups is stated in several of the latter patents to be an advantage; the nitrated amino phenol ethers, as 5-nitro-ortho-anisidine, are instanced. Other negative groups are also stated to be an advantage.

Generally speaking, although these salts can be precipitated under the condition of formation they dissolve readily enough when placed in water again, giving clear solutions. Their solubility, however, can be enhanced when necessary by mixing with salts of other sulphonic acids, *e.g.*, benzenesulphonic- and benzenedisulphonic-, phenylmethanesulphonic-, 1,6-, 1·7-, and 2·7-naphthalenedisulphonic acids. This device applies to the other types of soluble derivative as well; sodium naphthalene-1·6-disulphonate is added to the zinc chloride double salt of alpha-diazo-naphthalene (B.P. 273,352, I.G.F.A-G). The stable salts have little or no colour and are readily filtered; they may be dried and ground at moderate temperatures without danger, or alternatively they may be mixed with partially dehydrated salts and then dried; in this connection alum containing 8 or 9 instead of the normal 24 water molecules is mentioned (B.P. 246,818, 246,870, Greisheim Electron) and this method of drying is applicable to the zinc chloride double salts and in fact to the stable diazo compounds generally.

In addition, other solubilising agents can be added if desired, the final products readily give diazo solutions on dissolving in cold water.

Other Methods

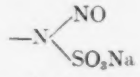
A method of obtaining much the same results as far as the dyer is concerned, but which does not involve the preparation of the diazo body, consists in mixing solid sodium nitrite with an aromatic nitro-amine, a bisulphate, a diluent such as alum, and an aryl sulphonic acid to improve solubility. Such preparations are stable and also give the diazo body immediately on dissolving (G.P. 426,033, I.G.F.A-G).

Variations of the Normal Development Process

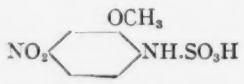
While dealing with methods of applying the development colours some other improvements in addition to the production of stable derivatives may be mentioned.

Instead of impregnating the fibre with the naphthol or other coupling component and then passing this through the solution of the amine diazotised by the addition of sodium nitrite, the nitrite may be added to the naphthol solution and the fibre then passed through the amine (B.P. 262,537, I.G.F.A-G). With proper adjustment of the proportion of sodium nitrite, this method offers possibilities of economy in the use of the amine, as only so much of this may be diazotised as is necessary for coupling with the naphthol. The method may be used in conjunction with naphthol AS colours, and is convenient for printing.

A new printing process for obtaining fast prints is to be found in B.P. 262,978 (I.G.F.A-G). A mixture of an alkali salt of an azo component and of a salt of an aromatic sulpho-nitrosaminic acid is fixed on the fibre and the dyestuff then produced by an acid treatment. Both constituents are thus fixed on the fibre at once. The sulpho-nitrosaminic acid grouping is as follows :—



and it has the advantage that it can easily be prepared from the sulphamic acid. In one example, 5-nitro-anisidine-sulphamic acid,



is treated with hydrochloric acid and sodium nitrite, when it is converted to the nitrosaminic acid. This is mixed with the alpha-naphthalide of 2·3-oxy-naphthoic acid, made up into a paste, printed, and steamed, when a bordeaux colour is obtained.

Dyestuffs Markets: The Month's Business in Review

From Our Own Correspondents

Lancashire

THE dyestuff market was featureless during the month; the business done being of about the same order as in two or three preceding months.

A statement by Mr. G. E. Holden has focussed attention on the fact that the Dyestuffs Act has only a relatively short period to run, and will no doubt prove to be the commencement of much argument on the manner in which the dyestuff industry must be fostered, and it will have to be fostered in order to survive in this country.

Dyestuffs manufacturers, few in number, will probably have but the one point of view; dyestuffs users have the most extraordinarily divergent view from an extreme where a dyer considers that he cannot exist without cheaper prices to an extreme where a dyer considers that prices of dyestuffs play very little part in the success of his business. They are probably both right, and it may be that one succeeds by looking after the pennies and the other by chasing the pounds. The threshing out of the problem promises to be a very interesting one with possibilities of surprise in the solution.

The Blundell *v.* British Dyestuffs Corporation, Ltd. case did not live up to the first sensational headlines in the daily press, and the settlement out of court was probably the only equitable solution. The case serves as a reminder of the extraordinary looseness of the modern business structure, accounted for by speed for the most part and only made possible by mutual goodwill. It may not be generally known that a great deal of business litigation in the Manchester district has been obviated by the common practice of the submission of cases to the Manchester Chamber of Commerce for arbitration, whereby the northern disputants are more likely to get what they commonly claim is all they want, namely, "their own," than they would be if the strict legalities of the case were adhered to.

The cotton trade in Lancashire has had rather a better month and even the American yarn spinners would appear to have at last shared in the increased prosperity. Nothing, however, has transpired during the month to indicate that any changes have taken place fundamental enough to hold out any promise of continued prosperity.

Yorkshire

Last year we were continually being promised better trade and a return to prosperity, but towards its close found that whilst the promise continued realisation failed. For this year it can at least be said that better trade has been experienced, and to add to their comfort the dyestuff manufacturers have heard the opinion of the large dyers in Scotland, expressed by Mr. J. Harrison at the meeting of the Association of British Chambers of Commerce held recently in Plymouth, that British dyestuffs now obtainable are quite satisfactory and reasonable in price. October has probably been the best month this year, and the second best was perhaps March.

With regard to the textile trade the situation does not change materially. In the heavy woollen district there is a distinctly hopeful note in evidence, and manufacturers are generally accustoming themselves to changed conditions. In the old days trade was looked upon as bad when orders in hand were not sufficient to guarantee full time for months ahead. Nowadays the demand is for quick delivery and the manufacturer is content so long as he is just able to keep his mill going full time. In the old days orders were placed by merchants to meet what their experience taught them would probably prove to be the demand. Now they are placed only as the demands occur. Dutch manufacturers are reported to be sending considerable quantities of cheap cloths and making keen the competition in the home market. Local exports to Holland and neighbouring countries, however, are well up to the average. Blues, greys and browns are finding favour in fabrics for next spring. In the Huddersfield district more machinery is gradually coming into use, especially in the manufacture of worsteds.

Woollens are comparatively poorly placed; the only lively feature in that section appears to be sports tweeds. Colne Valley still struggles for recovery of lost trade. One large manufacturer is reported to have warned his workpeople to be as economical as possible with their money as he does not anticipate being able to provide them with anything like the normal amount of work.

A new industrial development in the West Riding was begun last month when the Boyeux Silk Sizing Co., Ltd., of Lyons, France, signed a contract for the purchase of a factory situated at Bank Top, Bradford, and last occupied by William Denham and Co., Ltd., manufacturers. It is required for the purpose of working a patented sizing process for both artificial and natural silk yarns and will be the only factory of its kind in Britain. It is not expected that the mill will open before the new year. The process is designed to eliminate the wastage that occurs during the weaving and knitting of silk.

A fire broke out early on the morning of October 24 in the Millshaw Leather Works, the property of W. L. Ingle, Ltd., at Churwell, Leeds, and caused about £10,000 damage. It destroyed a two-storey building in which were the dining and store rooms.

Scotland

Conditions were variable in Scotland during October, with nothing particularly satisfactory to report. In some districts employment has improved, but this improvement has been balanced by a corresponding decline elsewhere. In the Vale of Leven, trade has been fairly good, and the printers have been well occupied at Barrhead, but in some other districts four days per week only are being worked.

Even in the South of Scotland all the tweed manufacturers are not fully occupied, although there is no actual cause for complaint, but some makers have not yet received sufficient 1929 spring orders to keep all their machinery running, or to enable them to see very far ahead. The present high prices for wool are no doubt partly responsible for this. It is, however, considered unlikely that there will be any reduction, so that buyers who are holding out for lower prices are likely to be disappointed.

A start with the actual making of artificial silk is promised at the Tungland works for November, but it will be some time before some of the other works are as far advanced.

Schemes and suggestions with regard to the Dyestuffs Licensing Act become more frequent as the time of expiry draws closer, and these show great divergencies of opinion. At the recent meeting of the Association of British Chambers of Commerce at Plymouth several widely different points of view were put forward. Mr. J. Harrison, of the South of Scotland, contended that the dyestuffs in this country were quite satisfactory and that users were not prejudiced as compared with foreign makers as regards the prices.

The market for dyestuffs and chemicals has remained steady during the month.

Dyestuffs Monthly Supplement

Published in the second issue of "The Chemical Age" each month

Communications relating to editorial matter for the Dyestuffs Monthly Supplement should be addressed to the Editor, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4. Advertisement matter, subscriptions, etc., should be sent to the Manager. The Supplement is devoted to the interests of both manufacturers and users of dyestuffs, and contributions will be welcomed.

The Dyestuffs Act

IN his articles on the safeguarding of British Industries, now running in the *Times Trade Supplement*, Mr. W. J. U. Woolcock takes as his first legislative example the strongest he could possibly have selected—the Dyestuffs (Import Regulation) Act of 1921. The circumstances of its passage were quite special. There had been a clamant demand, in the interests of the textile industry, the development of a British school of organic chemistry, and provision for possible war contingencies, for the establishment of a British dyestuffs industry at all costs to make this country for the future independent of foreign supplies. That was one of the great lessons left by the war—the risk of assuming that foreign supplies that served our purposes under peace conditions would be equally available in war conditions. It was clear that if the desired independence of foreign dyestuffs was to be achieved, some form of temporary protection would have to be provided to enable the baby industry which had just been organised here to grow up and in time be able to hold its own against its adult and powerful German rival. So the Dyestuffs Act was passed with the assent of virtually all parties to give such protection by restricting importation to those foreign dyestuffs only for which licences were to be granted by a licensing authority.

For Ten Years

The Act was passed to run for ten years, that being considered at that time a reasonably long period of immunity from open competition. Nearly eight years of that probationary period have passed. "As the time of the termination approaches," Mr. Woolcock writes, "the whole question of future Governmental action in respect of the great industry which the Act was designed to promote will need very careful consideration in the light of the additional experience which the next two years will bring. But one thing is already certain, and that is that within the shelter of the existing Act the foundations of the dye-making industry have been well and truly laid."

What Has Been Done

This conclusion is based on the results achieved, which are examined in detail. In 1913, it is pointed out, the value of the exports from the United Kingdom of textile goods into which dyestuffs entered in some way or other was estimated at about £80,000,000. In addition there is, of course, a very large domestic consumption of similar goods, and a considerable range of other manufactures in which dyestuffs are used. Of the synthetic dyestuffs so consumed in this country about four-fifths were imported, but the United Kingdom's dependence on foreign sources of supply was actually greater than this, for of the British production a large part was made from imported intermediates. The cutting off of foreign supplies caused great difficulties to the textile trades after the outbreak of war, and gave rise to a widespread feeling that such a situation —which was not inevitable, as in the case of some raw materials of industry—must not be allowed to continue.

Mr. Woolcock produces some convincing figures in support of his main conclusion. According to the best available estimate, the British production in 1913 of synthetic dyestuffs of all kinds other than indigo was about 9,100,000lb. —a very large proportion of which was made from imported intermediates. As to indigo, only the very last stage of manufacture was carried on in this country; the requisite intermediates were imported in an advanced stage of manufacture. The annual production of all classes of dyestuffs since 1922, according to the returns received by the Development Committee, has been as follows :—

U.K. OUTPUT OF SYNTHETIC DYESTUFFS.

Year	lb.
1922	20,803,000
1923	33,101,000
1924	33,243,000
1925	32,693,000
1926	30,297,000
1927	39,552,000

This quantitative increase, satisfactory in itself, is made still more so by the fact that the production is almost entirely from home-produced intermediates.

Pre-War Position Reversed

Taking the above figures as they stand and comparing them with the quantities of foreign dyestuffs imported under licence, the latter represent only a little over 18 per cent. of the home production. When allowance is made for a certain amount of export trade in dyestuffs, the statement commonly made, that of the dyestuffs consumed in this country at the present time some four fifths are produced here and only one-fifth imported, may be taken as substantially accurate.

This increase in output has been accompanied by a steady increase in quality and in range, and in the production of new types of colours British makers have shown marked initiative and ability. Synthetic indigo is being made in quantities more than sufficient for the home market, and striking progress has been made in the manufacture of vat colours—a class of dyes of rapidly increasing importance. The production of vat colours and indigo in 1927 was seven times that of 1922. As to range, nearly 500 colours have been placed on the market during 1923–28. The greater proportion of these were produced in other parts of the world prior to their being made in Great Britain. A penalty had to be paid for the neglect of the British industry, and for some time after the passing of the Act all the energies of the dye makers were devoted to the production of colours in constant demand. More recently, however, it has been possible to break new ground.

Foreign Imports and Home Prices

The following table shows the number of licences to import foreign dyestuffs applied for and the number granted during each of the five years 1923–27, and the first nine months of the current year :—

Year.	Number of licences applied for.	Number of licences granted.
1923	6,079	4,341
1924	5,047	4,332
1925	6,376	4,879
1926	6,595	5,778
1927	7,467	6,753
1928 (9 months)	5,444	5,092

The rapid decline since 1925 in the number of refusals is

of course, simply due to the fact that as the procedure of the committee has become firmly established and generally known, would-be importers have ceased to apply for licences which there is small chance of obtaining. The actual quantities for which import licences have been granted have been, in the same years: 1923, 3,691,000 lb.; 1924, 3,036,000 lb.; 1925, 3,399,000 lb.; 1926, 4,233,000 lb, and 1927, 4,990,000 lb. Of the quantity licensed in 1927, about three-quarters were to be imported from Germany and nearly all the remainder from Switzerland; the German share has doubled in quantity since 1923–24 and increased very substantially in proportion. The only serious criticisms directed against the industry recently, Mr. Woolcock asserts, have related to prices. There has been a tendency in public discussions of this subject to exaggerate greatly the proportion which the cost of the dyestuffs bears generally to the total cost of producing dyed or printed textiles. There are, of course, cases in which it is substantial, and in any event whatever reduction can be made in the costs of dyeing is a matter of importance to the textile trades. The dye makers have made and are continuing to make every effort to do their share to bring about such reductions, and may reasonably expect others concerned to do the same. The trend of their prices has been consistently downwards. In the summer of 1921 dyestuffs reached their highest selling price when it was estimated that the average was 4s. 4d. per lb. By December, 1922, this figure had fallen to 2s. 6d. per lb., in 1926 to 1s. 8d. per lb., and there has been a steady reduction since then. To complete the comparison it should be added that the estimated pre-war figure was 1s. per lb.

Fashionable Shades for Spring

Imperial Chemical Industries, Ltd., issue an interesting pattern card of B.D.C. fashionable shades for spring 1929. Though the shades selected are distinctly stronger and more definite than those which have been in vogue for some time, they are still marked by a certain lightness and delicacy. The ten shades shown are Honeysuckle, a full but delicate tone made up of Lissamine Fast Yellow and Fast Red; Pewter, a distinctive shade in which yellows, reds, and blues are successfully combined; Parakeet, a very bright green, suggestive of the spring season; Petunia, a rich shade combining depth and brightness; Mirage, a serviceable-looking green; Crevette, a shade that recalls Honeysuckle, but is more delicate; Dune, which is true in colour to the name chosen; Afterglow, a rich and showy orange; Jersey Blue, a quiet but distinctly characterful blue; and Beechnut, a good clear shade well described by its name. The colours have more body in them than many of the recent faint shades, and show a tendency to return to firmer and more definite tones.

Solochrome Red ER

Solochrome Red ER is the latest addition to the range of chrome colours produced by the British Dyestuffs Corporation. It is intended for all types of wool materials, and is recommended for all purposes where chrome colours are employed. It is of particular interest as a component for mode shades, possessing excellent levelling properties, and the advantage of giving maximum development from a mildly acid dye-bath. For the dyeing of silk pieces it is suitable where it is desired to leave cotton and viscose artificial silk effects white. It is described as possessing excellent solubility, and is suggested as suitable for application in the various types of circulating machines. The pattern card shows the colour on slubbing, on woollen yarn afterchromed, and on woollen piece with cotton effects, afterchromed. The effect as shown in the piece with cotton effects is particularly good.

Caledon Green RC.

Caledon Green RC., the newly-discovered vat dyestuff now manufactured for the first time by Scottish Dyes, Ltd., has been already noted in THE CHEMICAL AGE. There is little more to add than an expression of appreciation of the continued progress, which this new dyestuff indicates, in British dyestuff research. Every achievement of this sort improves the reputation of British products, in addition to extending the range of British colours. Caledon Green RC. is itself a very good colour that will be welcomed in the trade, and it has the further technical advantage of dispensing with the use of mixed colours and of simplifying the mechanical processes employed in dyeing. Its production is one more among the notable achievements of Scottish Dyes, Ltd.

American Dyestuffs Progress

The American dye industry supplied approximately 94 per cent. of the requirements of the United States in 1927 and produced also an exportable amount of more than 26,000,000 lb. of dyestuffs, according to the Eleventh Annual Census of Dye and Other Synthetic Organic Chemicals.

In calling attention to the marked progress made in the industry, the Commission's report explained that in 1913 only 13 per cent. of dyes consumed in the United States were produced in this country, and those produced were derived chiefly from imported intermediates. Many new and important dyes have been produced in the United States in the course of the development of the industry.

The report shows that during 1927 the domestic dye and organic chemical industry made marked progress. Production of over 95,000,000 lb. of dyes exceeds that of any previous year in the history of the domestic industry. The domestic industry has not been content merely to follow in the footsteps of the older dye-producing nations but has developed many new and important dyes.

Fast Dyes

In 1927 considerable progress was made in the manufacture of fast and specialty dyes, including those for dyeing rayon and mixed fabrics. The production of vat dyes established a new record in that year, with a total of over 5,960,000 lb. as compared with 4,030,000 lb. in 1926. This class of dyes was not made in the United States prior to the war.

The production of coal-tar dyes by 55 firms in 1927 was 95, 167,905 lb., an increase of eight per cent. over the previous year's production. Sales in 1927 totalled 98,339,204 lb., valued at $38,532,795, at a weighted average of 39 cents per pound, or three cents per pound less than the corresponding average price during 1926. The average price in 1917 was $1·26 per pound. Competition between manufacturers has been severe and 38 firms have gone out of business since 1919.

Imports of dyes during 1927 were 4,233,046 lb., with an invoice value of $3,413,886 representing a decrease of 10 per cent. by quantity, and 16·5 per cent. by value from that of 1926. Exports of dyes in 1927 showed an increase in quantity but a decline of 8 per cent. by value from that of 1926.

Severe competition among the dye-producing nations of the world continued throughout 1927, as it has for several years past. In time the cartel arrangements entered into by the dye industries of foreign countries will doubtless check this excessive international competition. These agreements have as their main objects the division of the world's markets, the limiting of production, and the stabilisation of prices.

Fastness of Azo-Dyed Fabric to Sulphur Dioxide

By A. T. King, B.Sc., F.I.C.

The following paper was read by Mr. A. T. King, chief chemist to the British Research Association for the Woollen and Worsted Industries, before the autumn conference of the Textile Institute, and is here reproduced from "The Journal of the Textile Institute."

Success in the manufacture of textile materials reaches its climax in the pleasing appearance of the finished goods, and where coloured effects are required, it is efficient dyeing which puts the seal on the care and skill exercised in the prior stages of production.

Such success demands not only perfection in dyeing technique, which ensures that the dyestuff is evenly applied, but perfection of fabric, in the sense that when the dye is evenly applied, it will be evenly absorbed, and failure to meet either of these conditions means faulty results. In the case of the animal fibres especially, whose affinity for dyestuffs so easily becomes modified following even mild action of scouring and other chemical reagents, faults may develop for which the dyer is often blamed, but for which he is in no way responsible. On the contrary, although the concealment of blemishes by a fresh coat of paint has no parallel in dyeing, the expert dyer is often able, by judicious selection of dyestuffs, to secure even on unsound material a satisfactory levelness and penetration.

The Dyer's Responsibility

But assuming the attainment of apparent perfection when the goods reach their finished state, the dyer's responsibility is not ended. The quality of his work is measured not only by the appearance at the finished stage, but by the lasting quality of the colour under the vicissitudes through which the material normally passes when in use. To meet the latter his vocation must be a science as well as an art. The requirements of fastness of colour to light, washing, ironing, perspiration, industrial atmospheres, and so on, must be secured, having due regard to the purpose to which the material is put, as well as to processes antecedent to finishing, such as stoving, chlorination, scouring, milling, and potting, where any of these have to be applied.

Further, the successful choice of dyewares is contingent not only on a proper appreciation of requirements on the above lines, but also on the accuracy of the information available as to their resistance to the above influences.

The Stoving Test

An unsatisfactory colour may be used through disregard of requirements, or through the goods being put to uses which the dyer was not informed the dyeware would meet, but, apart from this, the dyer may be let down because the available information on the resisting quality of a dye is misleading. This has frequently occurred in the case to be discussed, namely, the resisting quality to sulphur dioxide. The only information regarding this has been that given by the stoving test, the object of which is to classify dyestuffs according to the alteration they undergo during the sulphur dioxide process of bleaching wool. Brighter shades are, of course, shown on bleached wool, and to obtain this the stoving process is applied after the wool is dyed, as this bleach is not permanent, and would be largely lost by dyeing afterwards.

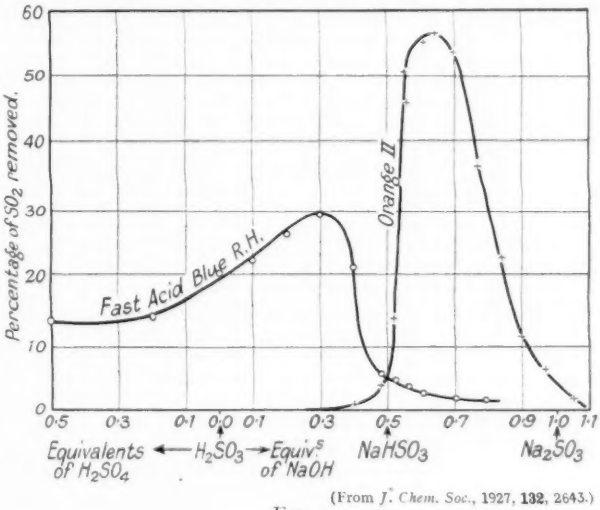
The employment of dyes in this way is relatively limited, and the general view has been that fastness to sulphur dioxide need only be considered in this special case, on the assumption that dyes which withstand the comparatively drastic conditions of the stoving test should give no trouble whatever under any less drastic contamination.

This may knowingly be present, for example, in dyeing material that has been stripped with hydrosulphite, or bottomed with Indigo, or arise fortuitously, for example, by subsequent contact with stoved white yarn, or paper wrappings made from sulphite pulp, or by exposure to air contaminated with sulphur dioxide.

It is under such circumstances, rather than in actual stoving, that reputedly fast dyestuffs go off-shade, and frequent faults are encountered. In view of this, the importance of a thorough understanding of the chemistry of the action of sulphur dioxide on dyed material should need no emphasis, yet this has been practically an untouched subject, apart from the practical test of whether or not a dye is altered by stoving.

The fact that certain azo dyes could form compounds with sodium bisulphite, markedly different in colour from the original dye, was observed first by Spiegel, and later by Voroschtsoff. The latter showed that the reaction was confined to naphthol derivatives, which, however, include a number of popular direct and developed cotton colours as well as acid dyes.

A more detailed study of this reaction (A. T. King, *J. Chem. Soc.*, 1927, 132, 2639) in the case of the simpler azo-β-naphthol dyes has shown that sulphur dioxide alone has no action, but that after a certain proportion of alkali is added, formation of the bisulphite compound (azo sulphite) commences, increasing rapidly to a maximum, and then falling equally rapidly with further alkali addition. This is illustrated in the accompanying curve, Fig. 1, for Orange II, showing the



(From *J. Chem. Soc.*, 1927, **132**, 2643.)

FIG. 1

percentage of azo sulphite formed in two hours when equivalent quantities of dye and sulphur dioxide were mixed in N/50 solution in presence of varying quantities of alkali.

Thus there is an "active range" of alkalinity for such dyestuffs within which sulphur dioxide will turn them completely off-shade, though they may be quite fast to this reagent alone. As the dye is similarly affected when on fabric which contains alkali, the practical significance of this reaction is obvious.

The various possibilities have been discussed in detail elsewhere (A. T. King, *J. Soc. Dyers and Col.*, January, 1928). The conclusion drawn is that the use of dyes of this type, however excellent may be their fastness to stoving as claimed by the colour maker, should be confined to goods which are finished acid. On wool-dyed or yarn-dyed material, the risk of going off-shade through contamination with sulphur dioxide is always present. Cotton retains far less alkali than wool, but sufficient to cause an off-shade on exposure to atmospheres slightly contaminated with sulphur dioxide.

It is noteworthy that as a whole, dyes of this class are scheduled as of good fastness to stoving. Thus Croceine Orange (26)* and Azo rubine (184) are given as quite fast (alteration 1); Orange G (27), Orange R (28), Scarlet R (78), Ponceau RG (79)†, and Orange II (151), with alteration 1-2, are reputedly good, and Pure Bordeaux B (88), Crystal Scarlet (89), and Acid Brown R (175), with alteration 2, are regarded as of satisfactory fastness. Within the "active range," however, they are all extremely fugitive.

Reasons for Good Fastness

In view of the standard stoving test being designed to imitate commercial stoving, which is carried out on scoured and therefore alkaline material, it is at first sight surprising

* These are the Colour Index Numbers.
† This colour, though azo-sulphite forming, yet when dyed on wool tends rather to bleach under "active range" conditions.

that such good degrees of fastness should be recorded. There are two reasons for this, firstly, as will be seen from the curve, with rapid neutralisation in an excess of sulphur dioxide the active range is quickly traversed, and the dye is then unaffected by further exposure. Secondly, the standard method of preparing the dyed pattern for test, by rinsing and then wringing it out of neutral soap solution, may not even neutralise the residual acid left in the wool after dyeing, let alone make the wool alkaline, and the active range is missed altogether. Thus the misleading character of the scheduled fastness to stoving, when it comes to choosing a dye of good all-round resistance to sulphur dioxide, is apparent.

Deductions from Constitution

Eventually our knowledge of the chemistry of sulphur dioxide effects on dyestuffs will be crystallised into terms of constitution, so that a glance at its formula in the Colour Index will enable an accurate conclusion as to the sulphur dioxide resisting property of a dyestuff to be drawn.

At the moment such deductions are of limited scope, but the preliminary conclusion that generally the β-naphthol derivatives were much more prone to the alkali-SO_2 effect than α-naphthols has been amply confirmed by Goodall (*J. Soc. Dyers and Col.*, May, 1928), who has tested a large number of Geigy colours under the "active range" conditions, and has found that every one of the β-naphthol derivatives was sensitive, whereas only one of the α-naphthol dyes was affected.

With α-naphthols the activity is practically confined to dyes with the α-naphthol nucleus unsubstituted, e.g. Orange I (150) and Acid Brown R (175). The only active dye with a sulphonated α-naphthol nucleus which has so far been observed is Double Ponceau (84), the sodium salt of α-naphthalene azo α-naphthol 5 sulphonic acid. Even the corresponding 4 sulpho α-naphthalene azo α-naphthol 5 sulphonic acid Fast Red VR (180) is inactive. Thus useful generalisations can already be made from the theoretical side as to all-round fastness to sulphur dioxide so far as naphthol dyes are concerned. Having first eliminated those dyestuffs fugitive to the standard stoving test, β-naphthol derivatives as a class are also eliminated, and only the α-naphthols as a class show immunity. Even the latter is contingent, of course, on absence of secondary effects, distinct from azo-sulphite formation, which can occur when certain substituent groups, particularly amino and acetyl groups, are present. For instance, Eriochrome Green H (99) direct dyeing is sensitive, although it is an α-naphthol derivative. Generally, however, such vulnerability is revealed at the outset by the standard test.

While the foregoing observations refer primarily to the monoazo naphthol dyes, dyes of the disazo class, with α- and β-naphthol coupled groups, which also includes an important number of direct and developed cotton colours, admit of the same generalisation so far as they have been examined.

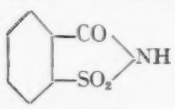
The misleading character of the present standard stoving test is not confined to azo dyes of the naphthol type. Goodall has quoted examples of dyes not containing this structure which fail under the "active range" conditions, though fast to the standard test. No doubt it will eventually be possible to classify this behaviour on a structural basis for all types. Meanwhile the question of all-round fastness to sulphur dioxide becomes even more significant in view of two further aspects recently pointed out (A. T. King, *J. Soc. Dyers and Col.*, August, 1928), with reference to fastness to light. Firstly, the azo sulphites are much more fugitive to light than the dyes themselves, so that dyes only slightly off-shade as a result of azo-sulphite formation will show a much greater fading change; and secondly, wool actually yields sulphur dioxide on exposure to light through oxidation of its constituent sulphur.

Thus the fastness of a dye to sulphur dioxide, hitherto a somewhat obscure factor, of limited scope, promises to rival in importance its fastness to light. It is not too much to claim that a more definite characterisation of fastness to sulphur dioxide on the part of colour makers, and due regard to it on the part of colour users, would not only eliminate the present frequent occurrence of sulphur dioxide faults, but make for a general improvement in efficiency and permanence of dyeing.

Basic Intermediates for Dyestuffs: No. XXIV—The Sulphonic Derivatives of Toluene

By "Consultant"

THE main outlet for the sulphonated derivatives of toluene in dyestuffs chemistry is in the preparation of the stilbene intermediates. Notwithstanding text-book statements to the contrary, however, the sulphonic acids of toluene itself do find some limited application in the industry. The main toluene sulphonic acid product is, of course, saccharin (148), which is substance of considerable value; in the course of its preparation there is obtained as by-product a considerable amount of toluene-4-sulphonic acid, which, in spite of attempts to dispose of it as Chloramine T (149), a powerful antiseptic,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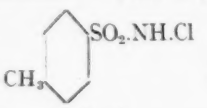
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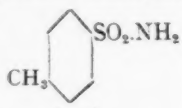

(150)

still remains very much in excess of the demand. Part of the surplus is used up in the dyestuffs industry for the preparation of condensation products between toluene-*p*-sulphonamide (150) and chloro- or aminoanthraquinones. The esters of the sulphonic acid will also condense in a similar manner.

Toluene-4-Sulphonchloride

The first stage in the preparation of this chloride is the preparation of toluene-4-sulphonic acid. Seeing that the corresponding ortho compound is the main product of this reaction, efforts are made to keep the yield of ortho as high as possible and to diminish the amount of the para compound formed. The earliest process (Fahlberg and List) involved the sulphonation of toluene with sulphuric acid, a reaction which has been quantitatively studied by Holleman and Caland (*Ber.*, 1911, **44**, 2504). These investigators showed that the higher the temperature the lower the yield of the ortho acid, so that it became customary to conduct the reaction at a temperature of 0° C., at which temperature 40 per cent. of ortho was produced, together with 4 per cent. of the meta compound and 56 per cent. of the para derivative.

In this process the toluene was stirred with twice its weight of 100 per cent. sulphuric acid until a test portion gave a clear solution on dilution with water. Throughout the sulphonation cooling is effected by the circulation of brine at -15° C. The finished sulphonation product is run out into water, limed, and converted into the sodium salts of the various sulphonic acids in the same way as with the sulphonic acids of the naphthalene series. Many ingenious plans have been devised for the separation of the isomeric ortho and para acids (the few per cent. of meta acid being ignored) such as the crystallisation of the magnesium salts, the para derivative crystallising first, or a similar process applied to the zinc salts, whilst separation may be effected by simple crystallisation of the acids themselves from water-sulphuric acid mixtures. Separation having been effected, it was customary to convert to the acid chloride by treating the acid with phosphorus pentachloride. At the present time the whole process is simplified by the use of chlorsulphonic acid as the sulphonating agent, the sulphonic chlorides being thus produced in one step.

The chlorsulphonic acid (4 cwt.) is cooled to 0° C., and toluene (1 cwt.) is run in with constant stirring, the temperature being kept below 5° C. throughout the whole addition by the use of brine coils. The plant may conveniently be of cast iron, and the lid must be closed during the operation, an entry-pipe being provided for the admission of toluene, and a wide exit pipe for the removal of the hydrogen chloride gas which is produced throughout the operation:—

$$C_6H_5CH_3 + 2HO.SO_2Cl = CH_3C_6H_5SO_2Cl + HCl + H_2SO_4$$

The actual sulphonation takes about 12 hours, but after this

period has elapsed, the stirring and cooling are both continued while strong hydrochloric acid is run in until the gravity of the acid mixture is 1·53. The temperature is not raised above 5° C. The sulphonic chlorides separate as an oily layer, and are removed from the acid layer. It is advisable to let the " oily " layer (which at 5° C. contains some solid matter) to warm up to room temperature before separation from the acid layer.

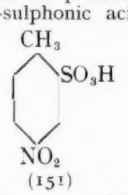
The separation of the para compound from the ortho derivative is done by taking advantage of the difference in their setting points. The pure para-chloride melts at 67° C., the pure ortho-chloride at 10° C. On cooling to 5° C. the para-chloride separates out in a fairly pure condition, until the residual oil contains about 85 per cent. of the ortho. The crystals of the parasulphonic chloride are removed by centrifuging. The quantities given above will yield about 1 cwt. of the ortho compound (85 per cent.), together with ¾ cwt. of the para-derivative, which is fairly pure.

Toluene-4-Sulphonamide

The formation of the sulphonamide by decomposition of the sulphonchloride with dilute ammonia is a simple and quantitative reaction which may be used for the large scale production of the amide. The apparatus required consists of a large digester fitted with a stirrer. Into this is pumped ammonia of 6 per cent. strength (S.G. O ; 975, 35 gallons) corresponding to an excess of ammonia of 7 per cent. The sulphonic chloride (1 cwt.) is melted and run in with very violent stirring, which is kept up until a sample of the solid does not yield an acid reaction on boiling with water (absence of unchanged sulphonic chloride). The sulphonamide is best separated by centrifuging and washing with water. No purification is necessary. The ammonium chloride in the mother liquor from the filtration is treated for ammonia recovery by causticising with lime and distillation.

The Stilbene Derivatives

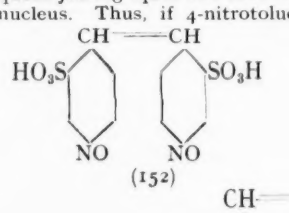
The parent compound for the production of stilbene derivatives is 4-nitrotoluene-2-sulphonic acid (151), a substance



(151)

which can be fairly readily prepared by the sulphonation of *p*-nitrotoluene. This substance (1 cwt.) is slowly run with constant stirring into " oleum " (30 per cent., 3 cwt.), the temperature being kept below 30 ° C., and stirring is continued until a sample of the reaction mixture gives a clear fluid free from oil on dilution with water (absence of any unchanged *p*-nitrotoluene). The stirring is then stopped immediately (any continuation leading to some disulphonation), and the reaction mixture poured out into a mixture of ice and salt. The quantity of salt is so adjusted as to give a saturated brine at ordinary temperatures. On allowing it to stand an almost quantitative yield of the nitrotoluene sulphonic acid sodium salt separates, and is filtered off, washed with a little brine, and used for conversion to the required stilbene deritative.

The fundamental reaction responsible for the formation of stilbene derivatives is the tendency which acids of the above type have to be oxidised at the methyl group with the consequent joining up of two residues to give a substituted stilbene nucleus. Thus, if 4-nitrotoluene-2-sulphonic acid is heated with 10 per cent. caustic soda solution, a deep red solution is rapidly obtained which contains 4 : 4¹-dinitroso-2 : 2¹-stilbenedisulphonic acid (152). This substance can be isolated, but if the warming with caustic solution is continued, a deep yellow dyestuff of unknown constitution is obtained, which has had a limited application under the name Stilbene Yellow.



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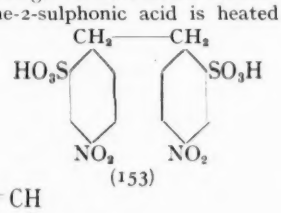

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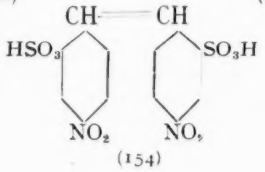


(154)

If an oxidising agent is added to the caustic solution referred to in the preceding paragraph, then a dinitro compound is produced in place of the dinitroso derivative. In this case the reaction proceeds with the formation of 4 : 4¹-dinitro-2-2¹-diphenylmethanedisulphonic acid (153), a pale yellow crystalline substance. Further oxidation leads to the formation of the dinitrostilbenedisulphonic acid (154), an important intermediate for the preparation of Chrysophenine. The amount of these two substances formed in a given preparation depends on the temperature and the concentration of the caustic solution. Thus the use of a little caustic at high temperature favours the formation of a stilbene derivative, whilst the use of excess of sodium hydroxide at a low temperature favours the formation of the diphenylethane derivative. In the preparation of Chrysophenine, the last traces of the diphenylmethane derivative must be removed, or else it will interfere with the subsequent processes.

To prepare the dinitrostilbenedisulphonic acid, the nitrotoluene sulphonic acid (1 cwt. calculated on the anhydrous acid ; the normal form contains $2H_2O$) is dissolved in water (230 gal.) together with caustic soda (⅔ cwt.). The mixture is stirred at 50° C. until solution is complete, when sodium hypochlorite solution (7 per cent. available chlorine, 56 gal.) is slowly run in and the liquid stirred at 50° C. until the smell of the hypochlorite has disappeared. On cooling the liquid and allowing it to stand for several hours the dinotrostilbenedisulphonic acid separates out in pale yellow crystals which may be separated from the supernatant liquid by centrifuging. It is, of course, the corresponding 4 : 4¹diaminostilbene-2 : 2¹-disulphonic acid that is actually used in practice. It may be obtained from the dinitro compound by the usual methods of reduction, best, perhaps, by the use of iron dust which is " activated " by a small quantity of hydrochloric acid. After the reduction, the clear liquid, filtered from the iron sludge, may be used directly for tetrazotisation, coupling, and ethylation to give dyestuffs of the Chrysophenine series.

The Future of Britain's Industry

SPEAKING at the Free Trade Hall, Manchester, on Wednesday, Lord Melchett referred to the condition and development of the steel and the dye industry. Unless, he said, the steel industry was prepared to give binding undertakings to re-establish itself on a modern basis, to disregard personal ambitions or traditions of the past, unless it was frankly prepared to reorganise itself on modern lines, it neither deserved nor could it expect to receive from either people or Government what in one form or another—whether safeguarding or otherwise—was a valuable privilege.

In the case of the dye industry which before the war hardly existed, Lord Melchett said that the Government adopted a bold course. It went much further than the safeguarding tariff. It actually prohibited the introduction of dyestuffs into this country except under special licence. Before the war, Britain imported 80 per cent. of its dyestuffs and manufactured 20 per cent. It was the Dominions to which we had to look to create a secure future for the exchange of our industrial products.

Dyestuffs Licences for November

THE following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during November, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee :—

The total number of applications received during the month was 665, of which 580 were from merchants or importers. To these should be added 13 cases outstanding on October 31, making a total for the month of 678. These were dealt with as follows :—Granted, 633 (of which 622 were dealt with within seven days of receipt) ; referred to British makers of similar products, 30 (of which 21 were dealt with within seven days of receipt) ; outstanding on November 30, 15. Of the total of 678 applications received, 643, or 95 per cent., were dealt with within seven days of receipt.

Technical Notes on Colour Lakes.—(1)

Production and Industrial Applications

The following notes on Colour Lakes are taken from the recent B.D.C. volume (noticed in the last "Monthly Dyestuff Supplement"), which contains some 73 examples of B.D.C. colours of this class.

GENERALLY speaking, colour lakes are complex compounds, either insoluble or almost insoluble in water, which are obtained by precipitating dyestuffs from their solution in water on to so-called bases or substrata by the addition of certain metallic salts, tannic acid, etc. In addition, simple mixtures of insoluble azo colours or insoluble vat colours with the various bases are also described as lakes by the colour lake manufacturer and user.

Bases which are also known in the trade as "carriers" or "substrata," have a deciding influence on the properties of colour lakes and may even be said to be more characteristic of the purpose for which a lake is to be used than is the dyestuff contained in it. In selecting a base the first and most important point to be considered is the purpose for which the lake is required. In addition, price, purity, covering power, fineness and physical properties must be considered. The bases can be classified as natural or artificial and may or may not possess colour.

The natural bases include natural barytes, china clay, chalk, ochres, green earth, white earth and gypsum (calcium sulphate). The artificial bases include aluminium hydrate, alumina blanc fixe, blanc fixe (barium sulphate) satin white, aluminium silicate, aluminium arsenite, aluminium phosphate, lithopone (mixture of barium sulphate and zinc sulphide), red lead, white lead, lead sulphate and zinc white. Such bases as alumina blanc fixe can be precipitated simultaneously with the colour, thus forming very intimate mixtures of base and colour lake.

Properties and Uses

Herewith is a general survey of the properties and uses of the most commonly used bases, arranged in alphabetical order.

Aluminium hydrate, owing to its transparent nature when ground in oil, finds large use in the production of colour lakes for printing inks. It is extensively used in conjunction with blanc fixe for the production of cheaper printing ink colours and pulp colours for paper surfacing. Aluminium hydrate has the property of combining directly with certain dyestuffs and, when used in conjunction with such dyestuffs, gives colour lakes possessing excellent transparency.

Alumina blanc fixe, which is usually produced by simultaneous precipitation of aluminium hydrate and blanc fixe, possesses medium transparency and good working properties and finds extensive use in the production of printing ink and paper surfacing colours.

Aluminium silicate, arsenite and phosphate are not used as such, but are formed simultaneously with the precipitation of the basic dyestuffs. Such lakes tend to produce slimy pulps possessing little covering power, but in the case of the aluminium arsenite and phosphate, great brilliance of shade. These lakes tend to dry hard, and are very fugitive to light.

Barytes is a very widely used base. It possesses little covering power when used in oil, and, therefore, is mostly used in conjunction with the more opaque pigments such as lithopone, lead sulphate, lead carbonate and red lead in the production of paint colours. It finds some use in the preparation of pulp colours, owing to its property of imparting fullness and brilliancy with small amounts of colouring matter.

Blanc fixe (precipitated barium sulphate), also known commercially as "Enamel white," finds extensive use in the production of pulp colours for paper surfacing, giving a good solid appearance and possessing excellent smooth working properties. Such pulp colours, however, retain very little water and very quickly become dry and hard.

China Clay is an extremely valuable base, and is generally used in conjunction with other bases such as barytes, blanc fixe and aluminium hydrate. It is capable of retaining from 50 to 60 per cent. of moisture, giving pulps of smooth appearance and finish, and, therefore, finds large use in the production of pulp colours. A commercial quality of China Clay is Catalpo, which is a finely divided China Clay finding large use in the production of pulp colours for paper coating where a highly polished finish is desired.

Chalk is little used in lake making. It is useful for eliminating traces of acid in colour lakes, but has a tendency to froth badly when mixed in size.

Green earth and white earth possess the property of precipitating the basic colours and, in conjunction with Brilliant Green Crystals Y, are extensively used in the production of so-called lime greens for distemper work. The quality of the earths used influences the fastness to light of the finished product to a very large extent, and it is always advisable to make actual trials and light exposures on the small scale before proceeding with bulk manufacture. Colours produced on green earth almost always give faster to light shades than do those produced on white earth. A good quality green earth will take up from 10-12 per cent. its own weight of colouring matter.

Gypsum (calcium sulphate) is used in the production of certain lime colours.

Lithopone is a mixture of barium sulphate and zinc sulphide and finds extensive use in the production of paint and distemper colours. It has the undesirable feature of being phototropic.

Lead sulphate finds its largest use as a substitute for baryte in certain classes of paint colours. It possesses only moderate covering power.

Ochres find use in the manufacture of paint and varnish colours, and are used to some extent in the production of pulp colours for paper surfacing. All the ochres possess excellent covering power, and, being themselves coloured, often serve the double purpose of base and colouring matter.

Read lead finds extensive use in conjunction with other bases and colouring matters for the production of permanent red and vermillionette shades.

Satin white is the trade name given to a mixture of calcium sulphate and aluminium hydrate, such a mixture being produced by simultaneous precipitation. Satin white finds extensive use in the paper surfacing trades, giving an excellent smooth finish to the paper.

White lead is solely used in the production of paint colours, possessing excellent covering power, but, unfortunately, has the drawback of becoming discoloured on exposure to city atmospheres containing sulphuretted hydrogen.

Zinc white possesses very good covering power, and is practically unaffected by atmospheric influences. Rarely used alone, its chief use is that of imparting increased covering power in admixture with other bases.

Preparation of Artificial Bases

Below are given formulæ for the production of the most commonly used bases. These formulæ cover, generally, those used in actual practice, but it must be realised that many manufacturers prefer to work to formulæ which, as a result of experience under local conditions, are found to meet their particular requirements.

Aluminium hydrate.—Care must be exercised in preparing this base, as dilution, temperature, and rate of precipitation influence the quality of the final product to a large extent. The following recipe gives a good quality aluminium hydrate :—

6 lbs. aluminium sulphate (18 per cent. Al_2O_3) are dissolved in
6 gallons hot water (60–70° C)

now slowly run in while stirring :—

2½ lbs. soda ash in
2½ gallons hot water (60–70°C)

The temperature is maintained at 60–70°C. throughout, and, when precipitation is complete, allow to settle and wash by decantation. The washing is continued until the paste is practically free from soluble sulphates, when the paste is dropped into the press and filtered. During the reaction sodium sulphate is formed, and as the presence of this substance would, on the addition of precipitating agents such as barium chloride, calcium chloride and lead acetate, form insoluble sulphates in the finished lake, it is necessary to wash the precipitated aluminium hydrate thoroughly if lakes of the highest degree of transparency are required.

(To be concluded)

Dyes and Their Application: Recent Technical Progress

By L. J. Hooley

In spite of the growing importance of artificial silk, the total consumption of this material represents at present only a few per cent. of the consumption of cotton. Again, acetyl silk is at present one of the minor members of the artificial silk group. In view of this, it is evident that acetyl silk cannot complain of any neglect with regard to dyestuff research. Considering the great practical improvement in the prospects of this substance which have taken place during the last year, it is hardly likely that this research will not continue. In view of the predominant part taken by Great Britain in the development of the silk, it is satisfactory to note the bulk of the dyestuff research is also being carried out here, and some of the latest ideas in this respect are given below.

Azo Dyes for Acetyl Cellulose

Azo colours provide such a large field, not only in regard to existing compounds, but also to possible new ones, that it is only to be expected that many new developments will come from this class, and a substantial portion of these will consist of previously described dyestuffs suitably modified to meet the special demands of acetyl silk. Blacks, of course, are always of importance, and some of the newest products for this purpose may be mentioned.

Complicated products are obtained by first dyeing the acetyl silk with a diamino-azo dyestuff, and then diazotising and coupling with a naphthol or a naphthol carboxylic acid (B.P. 281,704, S.C.I.B.). In B.P. 290,720 (I.G.F.A.-G.) dinitro-amino phenols are diazotised and condensed with amino-naphthols; thus, 4 : 6-dinitro-*o*-amino-phenol is coupled with 1 : 8-amino-naphthol to give a water-soluble black. Slight modifications in the naphthol give violet-black, brown-black and voilet shades. In none of these products are either carboxylic or sulphonic acid groups present. Before leaving the subject of blacks, the use of hematine may be referred to as a popular dyestuff for this purpose.

Somewhat similar to the products of the last patent are those of F.P. 619,329 (I.G.F. A.-G.), except that the beta-hydroxy ethyl ethers of amino phenols are employed. Thus, 4-β-hydroxy-ethoxy aniline, diazotised and coupled with 1 : 7-amino-naphthol, gives a red.

Nitro diazo compounds may also be coupled with 3-methyl-5-pyrazolone; a good yellow is obtained from diazotised *o*-nitraniline and 3-methyl-5-pyrazolone (B.P. 282,782, S.C.I.B.). In B.P. 274,283 (I.G.F.A.-G.), unsulphonated azo dyes containing dihydroxy ethyl amino groups are employed.

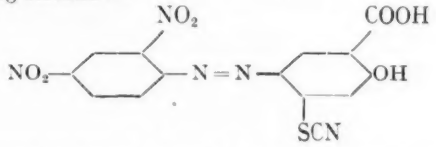
Substituted Amino Groups

The use of hydroxy ethyl groups will be noticed in the section above. Considerable extension in the principle embodied in this method of enhancing the solubility and dyeing properties of acetyl silk dyes will be found in a series of patents of Henry Dreyfus (B.P. 291,816, 292,181, 292,452, 292,453, 292,680). Cyanates, isocyanates, thiocyanates, alkyl-thiocyanates, isothiocyanates, alkyl-isothiocyanates, ureas, thioureas, urethanes, thiourethanes, and ω-amino-alkyl-ethers are mentioned. A series of these is formulated below :—

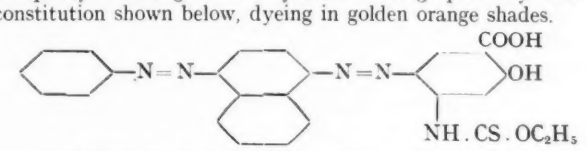
–CNO
–NCO
–SCN
–CNS
–$NHCONH_2$
–$NHCONHCH_3$
–$NHCSNH_2$
–$NHCSNHC_2H_5$
–$NHCSNHCH_2{:}CHCH_2$
–$NHCSOC_2H_5$
–$NHCOOC_2H_5$
–$NCOOCH_3$ (with CH_3)
–$NHCH_2CH_2NH_2$
–$NHCOCH_2NHCH_3$
–$NHCOCH_2NHCH_2CHOH$
–$NHCH_2CHOHCH_2NH_2$
–$NHCH_2CHOHCH_2OH$ (with CH_2OH)
–NH (with CH_2OH)
–$CH_2CH_2NH_2$
–$OCH_2CH_2NH_2$.

These groups may be attached to a variety of dyestuffs, including azo and anthraquinone colours. Some specific examples may be mentioned.

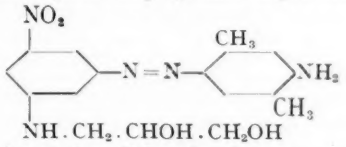
2:4-Dinitraniline is diazotised and coupled with salicylic acid-5-thiocyanate (obtained by treatment of salicylic acid with sodium thiocyanate and bromine), the product having the following formula :—



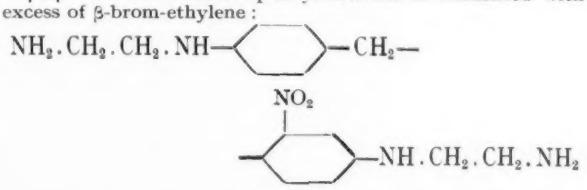
and dyeing in brown yellow shades. If salicylic acid-5-thiocyanate be boiled with alcoholic potash, the thio-urethane is obtained, and this, on coupling with diazotised benzene-azo-α-naphthylamine, gives a dyestuff having probably the constitution shown below, dyeing in golden orange shades.



2 : 4-Dinitro-chlorbenzene is condensed with γ-amino-α:β-dihydroxypropane, and one of the amino groups reduced, diazotised, and coupled with *p*-xylidine, to give a fast yellow :



4 : 4^1-Diamino-2^1-nitro-diphenylmethane is condensed with excess of β-brom-ethylene :



Application

From the application, as distinct from the synthetic side, the following features are of interest. The old device of swelling is coupled with the new one of solubilisation in B.P. 285,942 (Dreyfus). By this combination, dyeing can sometimes be carried out at temperatures as low as 40° C. The process is also of advantage with more than usually insoluble colours, where solubilisation alone gives a satisfactory product with difficulty.

Mordanting methods have not been used to any great extent with cellulose acetate, but some recent variations have been introduced which may be more effective. Thus mordanting may be carried out in very strong solutions of metal salts; for example, with concentrations higher than 15 per cent. Also, in mordanting with thiocyanates, an additional quantity of thiocyanate besides that present as the metal thiocyanate may be added. In some cases, metal salt solutions as high as 60 per cent. are recommended with the following mordants: aluminium sulphate, alum, chromium compounds, stannous chloride. Fibres so mordanted may be dyed with alizarine and logwood, as well as azo and other colours.

In B.P. 287,651 (I.G.F.A.-G), the fibre is padded with a triple mixture of the nitrite, the amine and the coupling constituent, and then passed through acid. The nitrite not only develops the colour, but assists the absorption of the azo constituents. The patent also contains a large number of examples of the dyeing of animal products. Permanganate and bisulphite are recommended for clearing whites after printing of cellulose acetate materials which have foundations of wool or silk (B.P. 270,657, Etab. Petitdidier).

Solubility of Dyestuff in Acetyl Silk

From the theoretical side, Kartaschoff has continued his investigations into the mechanism of the dyeing process. With Farine as collaborator (*Helv. Chim. Acta*, 1928, 813), the dyeing properties of a number of anthraquinone derivatives are compared. Dyeing was carried out from solutions of the colour in absolute alcohol; the concentrations of colour in the fibre and alcohol after dyeing were determined, and the results showed a substantially constant ratio for each individual colour, thus indicating that the process is a solution one.

It may not, of course, be assumed, although the process of dyeing appears to be a solution phenomenon, that there is no chemical combination of any kind between the dyestuff and the fibre. The necessary experimental details in the determination of the partition coefficients naturally require special arrangements in dyeing for the determination of the quantities of colour in the fibre and the solution with any accuracy. The effects of various groupings on the dyeing properties were also examined.

Dyestuffs Markets: The Month's Business in Review

From Our Own Correspondents

Yorkshire

NOVEMBER'S dyestuff trade was remarkable for its lack of feature. October was a good month, but the trade of November was something of the order of most of the other months of this year, just moderate, and an end-of-the-year decline is now expected.

The hopeful note reported last month as in evidence in the Heavy Woollen District continues, but in one key only, and that the development of business for spring wear. The secretary of the Dewsbury Employment Committee reports that the general position throughout the area is gradually becoming worse. Not a firm, he says, has all its machinery running even on those few days a week the mills are working. Mills that were doing fairly well three years ago are now standing empty, or with machinery that has not run for a considerable length of time. Keen competition is being experienced at home with fabrics from abroad at prices which local manufacturers state they cannot approach. In some instances prices are 1s. to 2s. per yard below those of the home products.

It would appear that the industry is suffering from the disease known as "dumping," which the late Mr. Joseph Chamberlain endeavoured so perseveringly to eradicate by means of his tariff reform proposals. The competing materials are mostly cheap smooth-faced cloths from Germany and Czechoslovakia. Huddersfield complains that German and Italian worsteds are being sold in this country at prices which make competition difficult. It is refreshing to read that there has been some slight improvement in the Colne Valley trade. Patterns for next winter are now being shown, and the prospects are that public taste will demand shades of brown, more particularly for the better class trade, blues, and greys.

We reported last month a fire of serious dimension at the works of W. L. Ingle, Ltd. This month a well-known Yorkshire carpet factory blazed to a devastating extent. The factory is the property of T. F. Firth and Sons, Ltd., of Heckmondwike, and is known as Flush Mills. The hoses of the combined fire brigades succeeded in saving the works, but the motor-rug department, offices, and warehouse were gutted and the valuable stock destroyed, together with the firm's books and patterns. The damage, covered by insurance, was very heavy, but as it was not to the machinery, Sir William Aykroyd, chairman of the directors, said that little, if any, unemployment would result.

A lightning one-day strike in which many Yeadon dye workers were concerned took place when 200 employees of Hill and Co., Kirk Lane Dyeworks, suspended operations. At a meeting held in the evening, however, the men decided to return to work the next morning. The trouble arose over what was regarded as "culpable negligence" of one of the employees. It was alleged that owing to his leaving his machine, about 20 pieces of 92 yards each were spoilt, and he was dismissed. On mitigation of dismissal to fourteen days' suspension the sympathetic strike collapsed.

Lancashire

THERE was during November a distinct improvement in artificial silk dyeing, though the dimensions are still below normal.

In yarn dyeing, vat colours continue to make headway.

The reductions in the price of acetate silk will certainly result in an increased application of this material, more especially for two-colour effects.

There was a recent advertisement in the *Manchester Guardian* offering a commencing salary of £750 to a foreman-dyer capable of dyeing artificial silks, including viscose and acetate mixed fabrics.

In wool dyeing there is increasing interest in the Neolan colours; one or two of these dyestuffs are finding regular use for artificial silk.

There is no general improvement in calico printing, and many machines are idle, but there has been an improved demand on some markets, notably South America.

A new method of producing comparatively level shades on viscose, which has recently been published by Courtaulds, Ltd., is likely to alter the requirements of dyers for dyestuffs for this material, since it is now possible to obtain good results with colours of better fastness to washing. Formerly, these dyestuffs notoriously produced the greatest differences between light and dark dyeing on artificial silk.

Scotland

THERE has not been much change in the state of trade in Scotland during November, which has remained, on the whole, moderately good.

The tweed manufacturers have been exhibiting their winter pattern cards, but at present, with the uncertainty of price tendencies, buyers have been holding off to some extent. The majority of the mills, however, are maintaining their output, although, as previously, they are not all fully employed.

The Scottish woollen manufacturers have been complaining for some time that the large amount of designing and related work which is put into new patterns is not adequately made use of by the buyers and distributors, who are too timid to take up new lines properly. The manufacturers are, therefore, getting together with a view to taking these matters more into their own hands and adopting a firmer attitude with regard to newer ideas.

Wool dyers on the whole are fairly well occupied. In the piece dyeing, yarn and printing sections business is as previously only moderate.

The proposals for the dyeing works at Balloch on Loch Lomond have been received with satisfaction in the Vale of Leven in view of the promise of greater employment. According to reports, this particular site was chosen because of the excellent quality of the water. There were some alarming suggestions that the quantity of water withdrawn would affect the level of the lake, but the new company can hardly hope for sufficient orders to do that. It is to be known as the British Silk Dyeing and Finishing Co., and French interests are stated to be included.

There have been rumours of a silk mill for Stirling also.

The wages question is still under discussion, and another meeting is arranged for December.

Dyestuffs and chemical sales have remained fairly steady. The new offices of Scottish Dyes, Ltd., at Grangemouth, are now beginning to approach completion, as far as outside work is concerned.

Metallurgical Section

Published in the first issue of "The Chemical Age" each month

235/64

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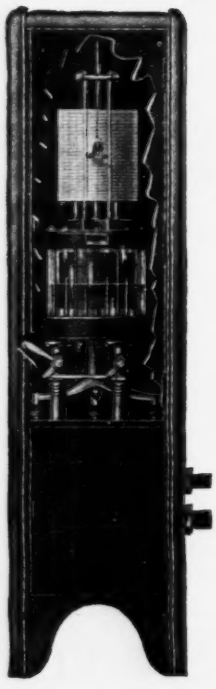

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The Uses of Cadmium.—(II)

By a Metallurgical Correspondent

Below appears the continuation and conclusion of an article of which the first part appeared last month. In this the author deals with the uses of cadmium in electric furnace resistors, arc lamps, paints, etc.

The voltage of a cell on discharge represents the difference of potential between two elements, each possessing potential. Cadmium happens to be a substance to which, as an electric couple, the positive and negative active materials are both electro-negative in sulphuric acid, and cadmium may, therefore, be employed as a medium for determining the comparative condition of the positive and negative elements during any state of charge or discharge (9).

By immersing a cadmium testing strip in the electrolyte of any cell and connecting it to one terminal of a low-reading voltmeter, and the other terminal to either one positive or one negative plate, a difference of potential is recorded. The ordinary cell-testing voltmeter will only indicate the actual difference of potential of the cell, but by the aid of cadmium and a voltmeter the potential difference of the cell can be analysed, showing in what proportion the positive and negative elements perform their functions to yield this potential difference, or, more accurately, the relative rate of alteration of p.d. of each element.

The most important use of the cadmium electrode is in detecting whether it is the positive or the negative element which is at fault in a weak cell. This test is generally made when the cell is discharged to the minimum permissible voltage for the particular rate of discharge, and while the discharge current is still flowing. Too much reliance should not be placed on cadmium readings in determining when a cell is charged fully. The value varies so much according to temperature, age, conditions of plates, and various local conditions, that a very misleading result might be obtained. Although the value of the cadmium testing strip has been known for some years, it has not yet come into common use; but, as its important value becomes generally appreciated, its employment is certain to be standard practice.

Electric Furnace Resistors

For use as a high-temperature resistor material, cadmium oxide is finely ground with water, with or without the addition of powdered zirconium silicate, and the paste shaped as desired and heated to 800° C. The oxide then forms a compact mass of high tensile strength, and is particularly suitable for the manufacture of electric furnace resistances on account of its low negative temperature coefficient of resistivity, even at 1,000° C. Its low specific resistivity at these high temperatures distinguishes it from most other metallic oxides. Initially, it must be heated externally, for example, by the use of a short subsidiary electrical circuit, but when once hot, the current will pass and the heating effect is obtained. The oxide has the further advantages that it is stable, especially at high temperatures, and that it is more durable and will withstand stronger heating than the usual metallic furnace resistors. It can be employed to produce furnace tubes and refractory articles, when other conducting or non-conducting refractories may, if desired, be added before baking (Pilling and Bedworth, U.S.P. 1,467,810).

Cadmium Vapour Arc Lamp

A cadmium vapour arc lamp, which gives an intense monochromatic red light, practically that of pure cadmium, by means of the line 6,459, had been devised, and constructed by Bates. (10) The lamp is in the form of an inverted U-tube of 10 c.c. capacity, and is fitted with two long quartz capillaries at its ends, by means of which the tungsten wire electrodes are admitted. The electrodes are fastened into the capillaries by means of lead seals. The lamp is filled by distilling, from a quartz bulb attached at the bend of the U-tube, a gallium-cadmium alloy containing 2 to 3 per cent. of gallium. During the distillation the cadmium carries over a minute quantity of gallium, which is sufficient to keep it from breaking the tube on solidification. The presence of the gallium also renders the cadmium soft and prevents its expansion, thus further avoiding breakage. The distillation is carried out at 0.001 mm. pressure, and when sufficient alloy has been distilled into the lamp, the narrow tube by which the bulb is connected is sealed off.

The lamp will burn with 110 volts and 3 amperes with a drop of 14 volts across the terminals, but is more efficient with a current of 7 amperes and a drop of 25 volts. To start the lamp one limb must be heated with a bunsen flame. The lamp is durable and requires little attention, and is free from clouding by adhesion of cadmium to the walls.

Cadmium amalgams or cadmium-mercury alloys were at one time largely employed as dental amalgams, but, as these alloys caused staining of the dentine, their use has been discontinued in favour of palladium amalgams. For cheaper work it is probable that some of the mixtures of cadmium with tin, mercury and lead are still to a certain extent employed.

Paints, Colours and Glazes

In the production of valuable colouring matters cadmium has one of its greatest uses; it is, in fact, probable that more cadmium is used in this way than in any other. The sulphide, obtainable in all shades from lemon-yellow to deep orange-red, is one of the finest and most permanent of pigments, the lemon-yellow shade being that most generally ground in oil for the use of artists. A coating of the paint is given to street cars and vehicles over a coat of chromium-yellow or a cheaper body, and the cadmium sulphide, being entirely unaffected by hydrogen sulphide, keeps its yellow colour with great permanency. The sulphide is also used for tinting rubber goods, toilet soaps, and candles, and finds employment in pyrotechny on account of the rich blue flame produced during combustion.

Cadmium in various forms is used for colouring glass, porcelain, etc., and in the preparation of enamels. (11) The Corning Glass Works, Corning, N.Y., U.S.A., use several tons of cadmium suphide annually to produce a yellow colour. The company manufacture lantern globes and roundels for railway signal purposes, the red being obtained with selenium and the yellow colour with cadmium sulphide.

Cadmium lithophone is a field of application for cadmium which offers promise of expansion, the rich yellow-orange colour of the pigment doubtless being of value in certain directions. At the present time cadmium lithophone is not to any large extent prepared.

The reaction by which the lithophone is usually prepared is as follows:—

$$CdSO_4 + BaS = CdS + BaSO_4.$$

A new process for making a cadmium-zinc-barium pigment, which is essentially a cadmium-zinc lithophone, has recently been described. (12) According to this process zinc-dust pre-

cipitates from zinc sulphate solution obtained in the hydrometallurgical treatment of complex ores are treated with sulphuric acid at such a temperature that the zinc and cadmium dissolve, but not the other metals. After filtration, the zinc-cadmium solution is treated with a suitable sulphide; the precipitate is washed, dried and ground, yielding a pigment of deep yellow to orange colour.

Cadmium lithophone (13) in which the zinc of standard commercial lithophone is replaced by cadmium, shows good covering properties, and a high tinting strength—an admixture of only 5 per cent. of cadmium lithophone with 95 per cent. standard lithophone giving a pleasing and distinct cream-yellow when rubbed out in oil. The manufacture of cadmium lithophone follows in general the procedure for zinc lithophone, though certain precautions not required when zinc is used are necessary, and under control of the operator considerable variation in the shade and depth of the yellow colour of the product may be obtained. The use of metallic cadmium as raw material is to be avoided, technically because of the difficulties of getting it into solution as pure sulphate, and commercially because of its high cost. In the process for separation of the associated elements from solutions to be used for the production of electrolytic cadmium, a combined solution of zinc and cadmium sulphates, containing approximately equal parts of each, is obtained; and, according to Webster, the cadmium sponge which is precipitated from this solution for re-solution as sulphate relatively free from zinc, would form a suitable raw material for the preparation of cadmium lithophone. The presence of thallium in small quantity has not been found detrimental, and its removal would in all probability be unnecessary.

The cost figure for cadmium lithophone, using the cadmium sponge, has been estimated at 15d. (29 c.) per lb. taking cadmium as at 2s. 6d. (60 c.) per lb., and allowing a 20 per cent. profit.

On account of the high tinting strength of cadmium lithophone, and because in most commercial uses it would probably be mixed with a large proportion of zinc lithophone or other white pigment, lithophone made from the equal part sulphate solution would possess colour and other values sufficient for most purposes. Where cadmium lithophone is thus made in combination with zinc lithophone, by reason of lower cost chargeable to cadmium than the above (60 c.) figure and of greater bulk, the product should cost appreciably less per lb. than the above 29 c. figure for the cost of cadmium lithophone content of the combined zinc and cadmium lithophone. Thus it is seen that, given a source of cadmium at cost comparable with the above, the manufacture of cadmium lithophone would be profitable, especially when carried out in connection with some other allied industry, as would probably be the case.

Cadmium has recently been employed to produce some beautiful coloured enamels (14), consisting of cadmium sulphide and selenide combined together; these have been to some extent used for the decoration of articles of jewelry.

Cadmium sulphate is used to produce yellow or orange reserves on dyeings with vat dyestuffs and in calico printing.

Other Uses

On account of their solubility in alcohol, the iodide and bromide of cadmium are used in photography for the preparation of light-sensitive gelatine plates. Chemically, cadmium has certain uses. As a reducer in volumetric analysis it is preferable to zinc dust. As an absorbent for sulphur in the determination of the latter in steel the salts are well known, and as an absorbent for mercury vapour in place of gold leaf, a tin-cadmium alloy is often employed. Cadmium is sometimes added to gold bullion assays when it is desired to determine small percentages of silver in bullion containing copper and platinum (15). During the war there was considerable employment of smoke bombs for signalling, in which cadmium was an important smoke-producing component.

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The Extraction and Applications of Thorium.—(I)

By G. Malcolm Dyson, Ph.D., A.I.C.

Thorium and its compounds are coming increasingly into use as catalysts and for other purposes, and this account of the extraction and uses of the element will doubtless be read with interest. Previous articles by the same author, dealing with numerous other non-ferrous metals, have already appeared in this supplement.

This year marks the centenary of the discovery by Berzelius in 1828 of the tetravalent element thorium in the mineral thorite, from the island of Lövön, in Norway. During the hundred years that have elapsed since its discovery, thorium has been found in many minerals, has been adapted for use in industry, and the metal itself has recently been prepared on a comparatively large scale for the manufacture of thermionic valves. Although widely distributed, it is present almost invariably in small quantities, and often in admixture with members of the rare earth family, from which its separation is not easy. It is simplest to divide thorium-containing minerals into two classes, corresponding to the two main methods of extraction, namely, the "thorium-rich" minerals such as thorite—essentially a thorium silicate—and thorianite (an impure thorium oxide), which contains 50-60 per cent. of thoria, and the "thorium-poor" minerals such as monazites, which, except on "selected" samples, seldom contain more than 10 per cent. of thoria.

Monazite is a mineral which is essentially a mixed phosphate of thorium, cerium, and lanthanum, and which occurs originally as crystalline inclusions in gneiss, granite and pegmatite. The weathering of these rocks gives rise to a sand containing monazite grains, the so-called "monazite sand," extensive deposits of which are found in India, Brazil, and especially in Espirito and Bahia. Since monazite has a high density (4·8-5·5) it is easily separated from other constituents of the sand by mechanical treatment; indeed, in the deposits of Travancore this separation is effected naturally by the mechanical action of the sea, which "concentrates" the monazite along the high tide level. The value of a monazite deposit depends to a large extent on the percentage of thorium it contains. Formerly the American (Carolinas) deposits containing 3½–4 per cent. of thorium were utilised to a considerable extent, but recently the Espirito Santo deposits containing 9–10 per cent. have been found more profitable. Selected specimens of the three thorium minerals have been analysed thus:—

	Thorite from Lövön.	Thorianite.	Monazite.
ThO_2	58·91	78·86	17·95
SiO_2	19·31	—	—
UO_3	1·64	15·05	—
Fe_2O_3	3·46	0·46	—
Mn_2O_3	2·43	—	1·86
CuO	2·62	—	—
MgO, K_2O, Na_2O, Al_2O_3, CaO ..	0·68	1·13	1·68
H_2O	9·66	—	—
P_2O_5	—	—	28·50
PbO, SnO	0·83	2·59	2·10
Ce_2O_3	—	1·02	26·80
La_2O_3	—		22·0
Helium	—	0·39	—

Extraction from the Ores

The methods applicable to the large-scale separation of thorium compounds from the minerals which contain them may be divided into two classes: those for the treatment of thorium-rich minerals, *e.g.*, thiorianite, and those by which the ores poor in thorium, such as monazite, are made to yield their values.

For the thorium-rich minerals a preliminary hand sorting is given, followed by an acid extraction. Hydrochloric acid was formerly used for this purpose, but more recently sulphuric acid has been substituted, since it decomposes the silicates and coagulates the silica more readily. The whole mass is heated in cast iron pans until quite dry, after which the thorium, together with certain metallic impurities, is extracted by means of very dilute nitric acid. Treatment with hydrogen sulphide serves to remove the heavy metals as insoluble sulphides, and the filtered solution is treated with oxalic acid, a step which serves to precipitate thorium and all the rare earths. Ignition of the well-washed precipitate having changed the oxalates to oxides, these latter are converted to sulphates by the use of concentrated sulphuric acid, excess of which is removed by heating in large quartz basins. The pasty mass of sulphates which remains is dissolved in ice-cold water, and the solution is allowed to warm up slowly to 20° C., when thorium sulphate octahydrate separates out and can be removed. The solution in ice-water and separation as the octahydrate may be repeated until the product is white.

Alternative Methods

Numerous alternative methods of working up the crude oxalate precipitate obtained above have been patented. Chief amongst these is the process which depends upon the varying solubilities of the rare earth metal oxides in solutions of ammonium oxalate. The crude oxalates are converted to the pasty sulphates as described above, and after treatment with sodium thiosulphate the crude thorium hydroxide $Th(OH)_4$ is precipitated together with the rare earths. It is washed with water and boiled with 15 per cent. ammonium oxalate solution. The solubilities of the various oxides in the menstruum is given below:—

Oxide.	Ratio of Solubilities.
Thorium oxide	2,663
Ytterbium oxide	105
Yttrium oxide	11
Cerium oxide	1·8
Neodymium oxide	1·5
Praeseodymium oxide	1·2
Lanthanum oxide	1·0

The consequence of the difference in the solubilities is that the thorium is almost entirely separated from the other similar elements.

Extraction from Thorium-Poor Minerals

The working up of minerals poor in thorium is a more difficult matter, and in some refineries the actual processes are protected as trade secrets. Concentration by oscillating tables and sluice boxes is capable of raising the amount of monazite to 40–50 per cent., after which a series of magnetic separations serves to remove further impurities. The first separation in a comparatively weak field serves to remove magnetite and coarse ilsemannite, whilst the second separation in a more powerful field removes the garnets and finer ilsemannite.

The first stage in the chemical treatment of the concentrates is usually the elimination of the phosphorus. Technically, this can be made a profitable operation if the facilities of a modern plant are available. The crude monazite is mixed with petroleum coke (1·1 parts), lime (0·8 parts), and fluorspar (0·15 parts), and the whole heated in an electric furnace adapted for the preparation of elementary phosphorus, which distils over, leaving a residue which is almost phosphorus-free. The residue designedly contains a fair proportion of calcium carbide, which is decomposed with water and the acetylene utilised. The final residue, after treatment with water, is in a very finely-divided condition, particularly suited for solution.

The thorium, at this stage, may be extracted by the methods described above for the thorium-rich minerals, or the sulphuric acid solution may be treated with hydrofluoric acid and the thorium precipitated as thorium tetrafluoride, ThF_4. This salt is readily soluble in a solution of sodium bicarbonate, and the hydroxide can be precipitated by means of caustic soda.

Berzelius, in 1829, claimed to have obtained metallic thorium by the action of potassium on thorium tetrachloride, but since that date it has been shown that the metal so obtained must have been exceedingly impure, for even if redistilled thorium chloride and pure sodium are used, the metal is so finely divided that oxidation during the washing is inevitable. The reduction of the oxide has been tried on a small scale by numerous investigators; Winkler used magnesium, Honigschmidt silicon, Troost and Moissan carbon, and Huppertz calcium vapour. Our knowledge of metallic thorium is due in the main to the application of the calcium method by Marden and Rentschler, and the large-scale production of thorium metal is a matter in which attention to detail is of very considerable importance.

Preparation of Metal Difficult

The difficulties of the calcium reduction are partly due to the fact that it is not easy to get the reaction to proceed to completion, and partly to the fact that impurities (which affect the course of the reaction adversely) are very easily introduced, both as iron and silicon in the calcium used, and as carbonate from the exposure of the calcium metal to the atmosphere. Mechanical difficulties comprise the construction of high-pressure bombs and the temperature regulation of the charge. This latter is important, since the temperature determines the size of the metallic particles produced.

Experiment has shown that the best way of preparing the calcium for the reduction is to electrolyse fused calcium chloride with tantalum electrodes, the calcium so obtained containing less than 0·01 per cent. of iron and silicon. The tantalum electrodes stand up very well during this process, and are not attacked by the chlorine as are platinum electrodes under the same conditions. The lumps of calcium are rasped immediately before use. In actual practice the use of metallic calcium could be replaced by the use of a mixture of sodium and anhydrous calcium chloride which has been dried at 450 C. for some time, the thorium chloride of the older processes being replaced by thorium oxide. In this way the reaction that actually takes place would be written:—

$$ThO_2 + 2CaCl_2 + 4Na = 4NaCl + 2CaO + Th$$

The thorium produced, however, is too finely divided.

Reduction of the Oxide

Thorium oxide is best prepared for the reduction by the ignition of the nitrate in tantalum dishes or pans, first at 400-500° C., and then at 800-850° C. The bombs in which the reduction is carried out are drilled from ingots of mild steel (cold rolled), and the stoppers are carefully ground in, so that no displacement takes place due to warping on heating. They are best cleaned with a mixture of hydrochloric acid and 75 per cent. formic acid.

The charge consists of equal parts of thorium oxide and calcium chloride, which are mixed and placed in the bomb, and then immediately covered with raspings of calcium ($\frac{3}{8}$ths of the weight of the rest of the charge). The stopper is placed in position and the cap screwed on, after which the bombs are heated to 950° C. in an electric furnace, in which they take approximately an hour and a half to reach the temperature of the interior. They are kept at 950° C. for an hour, and then cooled to a dull red heat and quenched with cold water. It will be noticed that an excess of calcium and calcium chloride has been indicated in the quantities given above. The reason for this is two-fold. In the first place, calcium chloride forms a flux and allows the thorium to settle out at the bottom of the bomb, and in the second place it dissolves the calcium oxide formed, giving the readily fusible oxychloride, 16·28 parts of the oxide being soluble in 100 parts of calcium chloride at 800-900° C.:—

$$ThO_2 + 2CaCl_2 + 2Ca = Th + 2CaO{\cdot}CaCl_2$$

The contents of the bomb are chiselled out and dropped into 20 litres of water, with vigorous stirring, which is continued until no more gas is evolved. The thorium is allowed to settle and washed with four changes of water by decantation. Four extractions then remove the various impurities; the product is stirred with 2½ litres of 15 per cent. nitric acid, when both hydrogen sulphide and acetylene are evolved, and then with water, alcohol and ether.

(*To be concluded.*)

Metallurgical Topics: Monthly Notes and Comments

From Our Own Correspondents

"Standardisation" in Plating Solutions

THE Electroplaters' and Depositors' Technical Society are making headway with the stupendous task to which they have addressed themselves, of standardising electro-plating practice, solutions, and even nomenclature. It has become evident, already, that there will have to be a lot of standards, for the requirements as to the thickness, hardness, etc., of a plating vary according to the uses to which the plated article is to be put, and there is nothing standard about that. However, from the wealth of data in the literature of the subject, supplemented by the actual practical experience of the members of the Society and the exchange of information and views with other workers abroad, it should not be impossible to arrive at certain broad and useful generalisations which may serve as foundations for "recommended" or "guaranteed" solutions and methods for specified purposes. More than this can scarcely be hoped for, and even this will take time and an enormous amount of work. The President of the Society, Mr. Field, is very much in earnest; the committee is a strong one, and even if the ultimate task be one of enormous difficulty, the information collected and co-ordinated can hardly fail to be very valuable.

Television

THE last few decades have witnessed the births of a succession of new industries, owing, in the main, to patient devotion to scientific researches of the type to which the term "academic" is applied, disparagingly, by those who ought by now to know better. "Wireless," the submarine, and the aeroplane have been intensely stimulative of metallurgical research, and have built up new subsidiary industries, the progress of which has been due mainly to the co-operation of the metallurgist and the engineer. Neither is, perhaps, directly responsible for the latest development, television, which rests on the basis of physico-chemical research, the ultimate foundation of the marvellous progress which is being made in countless directions. The pioneer work of some sixty years has materialised in a concrete industrial form by the flotation of Baird International Television, Ltd. In this undertaking are combined the results obtained by the subsidiary companies and the corporation formed to exploit the invention of Mr. J. L. Baird. As long ago as 1873 Willoughby Smith declared that by means of a telephone he could hear a ray of light falling on a metal plate. In a few years' time it will be a commonplace to see that ray instead and to transmit what is seen as easily and probably as cheaply as it is now possible to transmit sounds. The selenium cell has at last been brought to mundane and everyday uses, in the sense that what it can do is about to be extended, popularised, and "mechanised" on the grand scale.

Selenium and its Potentialities

Selenium belongs to the vague border-line between metals and non-metals, and may perhaps do no more than claim, as a justification for inclusion amongst the former, its metallic lustre, which is, of course, no claim at all. Its supply is derived mainly from residues from the metallurgical treatment of certain metallic sulphides, and although it has many uses in the arts, it has been chiefly a by-product of other industries rather than a direct object of extraction itself. It has many forms, amorphous, vitreous, soluble and insoluble, and both in the "metallic" form, and in combination with other elements has been the subject of much research work, its most interesting property being the variation in its electrical conductivity at different temperatures, and on varying degrees of illumination, particularly by red and ultra-red rays. It is also affected in a similar way by ultra-violet rays, and hence responds to a greater range of the spectrum than, perhaps, any other body, or at any rate manifests in a more tangible manner its response to such influences. Television, nocto-vision, and phonovision, three of the new terms with which we are about to become familiar, will owe their application and industrial and commercial exploitation mainly to these properties, but there is reason to believe that we shall yet have to coin new words to respond to the new functions which an intensive study of the behaviour of selenium and its compounds may further reveal.

The Sampling of Materials

IT is curious that while manuals of chemical analysis abound, giving methods which are improving to the point of perfection, they are for the most part silent on the subject of sampling, or deal with it rather inadequately and perfunctorily. The possible errors due to segregation are of course well known to metallurgists, and are duly provided against. Yet the bulk sampling of materials, upon which the whole value of the subsequent analysis depends, needs as much care, and is as full of pitfalls, as any purely chemical operation. One of the latest manuals dismisses it in a little over a page; some appear to regard it as altogether unworthy of reference; and in none is it done full justice. The sampling of dumps, wagon-loads, and barges containing ores is a most laborious and skilled operation, and a neophyte in the art is at a sad disadvantage with a skilled sampler. What boots it to use pure chemicals; to measure out quantities with meticulous exactitude; and to run blanks, as a check, if the sample does not represent the bulk? And in how many text-books will a warning be found against the trick of "drawing the cone," which will vitiate the result of even the most careful and conscientious sampling? The subject deserves much more attention in books than is given to it, seeing that so much depends upon sampling being done properly, and that so few people know even the rudiments of the art.

Stainless Steel for Ornamental Building Construction

STAINLESS STEEL stands up well to accelerated corrosion tests, and has proved its tarnish-resisting claims in homely domestic service. Its latest uses are for shop fronts; several such have been made of late and have a pleasing appearance. The older metal, bronze, thus has a serious competitor in stainless steel, which is being used for railings, fittings, and doors in banks and other office buildings. This leads to the question of the indirect effect of the use of substitute metals on copper. Not only may "stainless" displace bronze in ornamental metal work, but copper itself is being displaced to an extent hardly realised, both in its domestic uses and in its electrical engineering applications. Its rival, in the latter case, is aluminium, and the competition is likely to be greatly increased by the price reductions recently made in the white metal, and the probable increase in that of copper, owing to depletion of stocks, and to the fact that demand outstrips supply. There is not room for an infinite expansion in the use of metals, and the metallurgists who are busy inventing new alloys are doing so at the expense of the older metals and alloys. There are other considerations in regard to copper which make the situation serious, and, as far as this country is concerned, rather dangerous. However, stainless steel has come to stay, and those concerned with other metals threatened by its use must face that fact.

Cosmic Ray Investigations

In view of what the X rays have done for science in the way of opening up the inner secrets of the crystal and its structure, the last secrets of the atom itself may reasonably be expected to yield to the latest instrument of research, Cosmic rays. There is a good deal of very useful work yet to be done in gathering together certain threads at present scattered, but undoubtedly having a close connection with each other, and affording, collectively, a clue to many enigmas. Lead, the base end-product of some of the mystery-elements, possesses, for reasons which it is not difficult to understand, the property of screening off the very rays given out by some of its own transmutational manifestations. Selenium and sulphur are elements of the same group, and the selenides of lead have much in common with the sulphides. Specimens of artificial galena have recently been exhibited, the screening power of which, to the ordinary gamma-rays, is much greater than that of either lead or natural galena. Yet both are, virtually, transparent to the "unknown radiation entering the atmosphere from above." These constitute the *Höhen-*

Strahlung, or ultra gamma or cosmic rays of Hess, Millikan, and other observers. Rays have been observed ten times harder than the hardest of gamma-rays, with a penetration of close on 17 ft. of lead. Their wave-lengths are inconceivably small, tens of thousands of times less than an Angstrom unit. The galena "detector" and the selenide cell between them may be expected to afford great help in solving the problem of utilising these rays and applying them to scientific research.

The U.S.A. Steel Combine

In order to combat the competition of European producers in the United States foreign trade in steel, an alliance has been formed between the United States Steel Corporation and the Bethlehem Steel Corporation. The foreign trade of both companies will be conducted in future through an organisation (which has been formed for the purpose) known as the Steel Export Association of America. The two companies mentioned are respectively the largest and second largest producers of steel in the United States. The annual steel ingot capacity of the United States Steel Corporation is 23,035,000 tons, and that of the Bethlehem Steel Corporation 7,900,000 tons. The most important purchasers of American steel are Canada, South America, China and Japan. In Europe, the question of forming export selling agencies has loomed very large on the Continent. The Germans, who are strong advocates of unified selling, are believed to be making ground in their efforts to bring French and Belgian makers into line on this question, and it is more than likely that this American move will hasten matters. It is said that a similar movement is being discussed in this country.

Protection of Duralumin

The trend in aeroplane design towards all-metal construction, and extensive use of the strong light alloy duralumin, demands 100 per cent. permanence and reliability of this material. Doubt has been expressed from time to time concerning the permanence of duralumin in service. Sheet duralumin has in a number of cases been seriously impaired in its properties by becoming brittle without any marked accompanying change in its surface appearance. The great bulk of sheet duralumin in use, however, has not shown evidence of such a change, and at first manufacturers of materials as well as builders and users of aircraft held the opinion that no change in the properties of duralumin takes place. However, many well-established cases of severe deterioration have been found in sheet duralumin of varied origin. These have been shown to be the result of corrosion, the metal being attacked in a peculiar intercrystalline manner.

Intercrystalline corrosion of sheet duralumin whereby the metal becomes very brittle can be induced by accelerated laboratory tests. Chloride solutions are most effective, and the addition of an oxidiser increases the attack very decidedly. By means of such a solution, carried out as an intermittent immersion test on full-size tension bars on which the strength and ductility after corrosion were determined, it has been shown that all of the aluminium alloy sheets of the duralumin type, that is, heat-treatable alloys, are subject, more or less, to intercrystalline corrosion.

Heat-treated duralumins of essentially the same composition in the commercial heat-treated condition have been found to differ greatly in their corrosion-resistance. Composition does not appear to be the controlling cause, although alloys containing copper as the main alloying constituent are more susceptible than those containing little or no copper.

Effect of Various Treatments

Cold-working sheet duralumin after heat treatment renders it somewhat more susceptible to intercrystalline attack. However, this appears to be only a contributory factor. Material which is heat treated by quenching from a temperature considerably below the one at which the alloy constituents are soluble in the aluminium matrix is less resistant to corrosion than if properly heat treated, *i.e.*, quenched from 500° C. and aged at room temperature several days. The rate of quenching, that is, as determined by the quenching medium used, is a very important factor. Sheet quenched in hot water was found to be very much more susceptible than cold-water quenched sheet, although the static strength properties and the visible microstructure are the same.

Material which, after quenching, is subjected to accelerated ageing, that is, aged at some elevated temperature, was also found to be much more susceptible to intercrystalline corrosion than material aged at room temperature. For a high degree of corrosion resistance in sheet duralumin (not necessarily complete freedom from attack), the material should be quenched rapidly, as in cold water, from approximately 500° to 510° C., and aged at room temperature. When exposed to the weather such materials are giving results confirming the conclusions based upon accelerated corrosion tests.

Use of Protective Coatings

Although the resistance of sheet duralumin to intercrystalline corrosion can be greatly improved by proper heat treatment, protective coatings should also be used in order to assure complete protection. A coating of plain spar varnish is of relatively little use; when pigmented with aluminium powder, however, such a coating is greatly improved and appears entirely suitable to resist most atmospheric attacks. It is not to be relied upon for resistance to sea water, as in pontoons; a heavy bitumastic coating is suitable for this. An oxide coating made by the anodic oxidation process is of little use unless given a supplementary greasing treatment. This greatly improves such a coating and it appears to be very suitable for atmospheric service—not for parts immersed in sea water. The anodic process appears to be the best of the oxide or related processes.

Laboratory tests have indicated that "aluminium-pigmented" rubber coatings are exceptionally well suited for the protection of dynamically stressed parts (that is, parts subjected to vibration or flexure) under very severe corrosive conditions. Of the possible metal coatings, aluminium appears, from theoretical considerations, to be best. An aluminium coating applied by the metal spraying process gave 100 per cent. protection even under very severe corrosive conditions.

U.S. Production of Metallic Cadmium in 1927

The production of metallic cadmium in the United States in 1927 amounted to 1,074,654 pounds, an increase of 33 per cent. over production in 1926. The market quotation of American metal, New York, remained at 60 cents a pound throughout 1926 and 1927. There were 22,400 pounds of cadmium, valued at $13,172, imported into the United States during the last quarter of 1927. No imports of this metal were recorded for 1926 or the first three quarters of 1927. In addition to metallic cadmium, United States manufacturers reported some production of the following cadmium compounds, all in larger quantity than in 1926: Cadmium sulphide, cadmium hydrate, cadmium oxide and cadmium lithophone, but figures are not available for publication.

Lead Refining and Thermal Data

The Pacific Experiment Station of the United States Bureau of Mines, Department of Commerce, Berkeley, California, has been making special efforts to determine the entropy and free energy of arsenic and antimony, because it seems possible to use such data directly in certain problems having to do with the refining of lead. To date, data have been obtained upon antimony oxide and several of the oxides of lead, and special effort will be made to complete the data on arsenic as soon as possible. In the fire refining of lead, two steps are softening and fuming. The first of these separates some arsenic and antimony by oxidation of the impure metal, and the second, called fuming, produces a concentration of the resulting dross by reduction of these oxides, with subsequent volatilisation. The Bureau of Mines has received a number of inquiries for data on the oxides of arsenic, antimony and lead, and because of the direct use which these data may find in determining a rational control of fire refining methods for lead, it has seemed desirable to determine these data immediately. This field represents one of the cases where free energies, entropies and thermal data would seem to be directly applicable to an industrial process.

Trade, Commerce, Finance: The Month in Review

From Our Market Correspondent

We are now entering upon the second half of the year, and it must be confessed that there is no great cheer in the prospect from the point of view of those whose energies are devoted to the iron and steel industry. The experience of the first half of the year has not been satisfactory. A fairly steady level in the amount of business passing seems to have been reached, subject to slight variations up or down according to the seasonal influences which affect it; but all the time this level is so far below the normal requirements of the steel producing plants that it is a continual struggle to find enough work to keep the mills even partially employed. Notwithstanding the fact that the weight of steel being turned out compares very favourably with the pre-war production, there is a great margin between this quantity and the potential production. This is the condition to which we have had to become accustomed, not only during the first half of the present year, but for some years past.

One cannot see any sign of an improvement or a lasting change from such a state of affairs; indeed we are now coming to the time of the year when slackness in trade is most marked. We shall soon be in the midst of the holiday season, and past experience has shown that at this time business gradually falls away until the last quarter of the year is reached. Therefore those who are bewailing the wretched state of business at present are not likely to become any less despondent in the near future.

One or two of the steel works are managing to keep fairly busy, but they are the exception, and in the majority of cases the constant complaint is the shortage of orders. Even Guest Keens, with their profit of nearly one million pounds, have to admit that this has not been derived from their steel works, and that they, like other steel makers, have suffered considerably from lack of work in this department.

Little Prospect of Safeguarding

The hope of assistance from the Government under the Safeguarding Act has become very dim. A few years ago the Prime Minister made an election pledge which he considers binding. Apparently nothing will shake the Government on the point. Not even the very important deputation from the National Federation of Iron and Steel Manufacturers, which recently waited upon the Prime Minister, could induce him to change his attitude, although they put to him in the strongest possible way the urgent necessity of assistance.

The chairman of Guest Keen and Nettlefolds, at the annual meeting a few days ago, referred to this matter, and stated that it would seem that no assistance could yet be expected from the plan known as safeguarding. At the same time he pointed out that there was a great and growing body of opinion among the workmen as well as the employers that some method of this kind would have to be tried if disaster were to be averted. The rating relief promised in the Budget may be some relief to the distress, but its application is so far ahead that its value is considerably lessened.

Reconstruction of Baldwins

The financial reports of the steel companies are sufficient evidence of the true state of affairs. Financial reconstructions continue, the latest being that of Baldwins. The huge sum of 3¾ millions is to be written off as lost, and new money has to be obtained to enable the company to carry on. Even when all this has been done the root of the trouble may not be touched. Economies in management and production will afford some financial relief, but unless full and regular employment can be found for the plant it is difficult to see how prosperity can be regained. No amount of financial reorganisation will get more orders or increase selling prices to a remunerative level, and these are the crying necessities.

There is only one source from which this change can come, and that is a share of the trade which at present is going to the continental makers. To the South Wales makers this is particularly important. They are well situated for export business, but they find it difficult to secure a fair share of the ome trade owing to their geographical position. They are unable to secure it by the desperate method of cutting prices, as the bulk of the steel production is under the control of the associations. It is only in the case of certain classes of steel, such as boiler plates and special qualities, that this can be done, and the rapid fall in the price of boiler plates is due almost entirely to this factor. It is very disconcerting to the makers to find that owing to the unrestrained internal competition for the better priced classes of steel the margin of profit on them is quickly disappearing.

Question of Continental Prices

Much has been said about the recent advance in the prices of continental steel and the longer time required for delivery from abroad. At one time it did look as though this condition would prove of great advantage to the British makers, and judging from the recent reports it would seem that this advantage had materialised, but the actual evidence does not confirm this to any marked extent. The advance in the foreign prices has not brought them up to our home prices, and as for the time of delivery, it has long been known that a much longer time is required to get material from abroad than from the home works.

The only market which has really benefited is semi-finished steel, and even there the amount of extra business placed in this country is not great. One needs no other evidence of this than the low prices and keen competition for such work among the British steel makers. The reported condition at present on the Continent is not quite so firm. Prices have not receded materially, but quicker delivery is being given, as the output is much in excess of the new orders.

General Condition of the Market

Turning to the general market conditions, there is nothing striking to report. There is comparatively little business in pig iron. The state of the market is unfavourable to forward buying, and therefore consumers are limiting their purchases as much as possible. The particular competition among the Derbyshire and Northamptonshire makers has further weakened the market. This is the outcome of the placing on the market of the output from the new Stanton furnaces. Prices have been cut, but they are so low that this competition will soon have to cease. The export trade shows no improvement on recent conditions.

In finished steel there is no improvement in the volume of business. The official prices of controlled materials remain unchanged, following the decision of the associated makers at their meeting a few weeks ago. Small steel bar prices remain about the same, but they are so low that they can hardly admit of any further cutting. As already mentioned, boiler plates continue to fall in price, and as low as £9 5s. is talked of for acid quality. That price compares with £10 10s. about six months ago. Specifications for ship plates are not so numerous, as the demands from the shipyards seem to be falling off. On the other hand, the steel makers are faced with a probable increase in the price of fuel and scrap. Coal and coke prices are firmer in consequence of the output control scheme which is now in existence, and advances are being asked for the renewal of contracts. Scrap has also risen about 2s. 6d. per ton.

The output of pig iron in May amounted to 591,599 tons, compared with 563,100 tons in April. The number of furnaces in blast was 148, one less than in the previous month. Steel production amounted to 752,700 tons in May compared with 644,100 tons in April.

Tungsten in Canada

Recent developments at the Riverside mine at Stewart, B.C., have disclosed the presence of scheelite, the commercial ore of tungsten, in such quantities that the managing engineer, Mr. R. G. Mellin, has announced his intention of providing facilities in the concentrating mill for saving it. The amount of scheelite ore now in sight is said to be enough to warrant such changes in mill practice as will be necessary for its recovery.

Some Inventions of the Month

By Our Patents Correspondent

***Abstracts of other Patents of metallurgical interest will be found in our Patent Literature published weekly in* THE CHEMICAL AGE.**

Treatment of Zinc Waste

A HIGHLY economical process for extracting lead and zinc from spelter heap waste is described in Specification 290,035, dated May 3, 1927, by E. Bury, of Haltwhistle, and F. W. Walker, of Gilsland, Northumberland. The material is heated, *e.g.*, in a cement kiln, with coke having a high sulphur content (2 per cent.), lime or sand, and coal, by the use of a pulverised fuel flame having an excess of oxygen. The resulting fume, containing zinc oxide and lead sulphate, is either delivered to depositing chambers or is passed through a scrubber containing an acid for dissolving the zinc oxide, the lead sulphate remaining in the scrubber sludge. The lime maintains the charge in a suitable fritted condition and gives a kiln residue suitable for cement manufacture.

Heat Treatment of Ores

ARSENIC is removed from ores, mattes, speiss, and copper-arsenic compounds by admixture with sulphur-bearing and carbonaceous materials, and subjection of the mixture to combustion in a restricted supply of air, without the application of external heat. A multi-storey furnace with air-cooled stirrers is preferably used. See Patent Application 286,285, bearing the International Convention date March 3, 1927, by Norddeutsche Affinerie, of Hamburg, Germany.

PYRITES and other ores containing copper and zinc are roasted with an excess of sodium chloride at above 550° C. to convert most of the zinc into chloride and most of the copper into sulphate. Upon fractional lixiviation of the product the first fraction contains most of the zinc, and a later one most of the copper. The zinc may be precipitated by milk of lime, after removal of copper from the solution by means of zinc or iron. Any silver present is precipitated with the copper from the zinc solution. See Patent Application 288,266, bearing the International Convention date April 7, 1927, by Metallbank und Metallurgische Ges. Akt.-Ges., of Frankfort-on-Main.

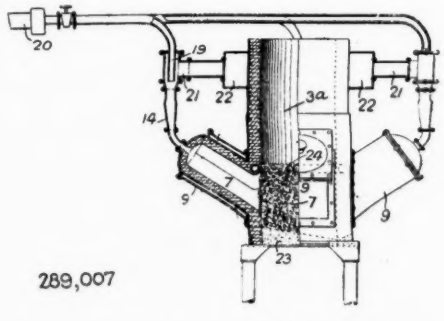
PYRITIC and other ores and metallurgical products are prepared for roasting or like treatment by admixture in a finely divided state with an aluminous binder, such as China Clay and iron sulphate solution, to form a plastic mass, the mass then being shaped into pieces, *e.g.*, rings, having a large superficial area and not liable to pack together. See Patent Specification 291,568, dated April 6, 1927, by F. L. Wilder, E. Morris, E. Schiff, and E. S. King, of London.

Refining Metals

MOLTEN metals and alloys, *e.g.*, of copper and nickel, are deoxidised by addition of beryllium or a beryllium alloy, generally to the extent of not more than 0·5 per cent. See Patent Application 288,543, bearing the International Convention date April 11, 1927, by Siemens & Halske Akt.-Ges. of Berlin.

Metallurgical Furnaces

AN improved cupola furnace is described in Patent Application 289,007, bearing the International Convention date



April 19, 1927, by The American Radiator Co., New York, assignees of D. H. Meloche, New York, U.S.A. Powdered coal or coke is burned in inclined combustion chambers 7, each opening into the lower part of a chamber 3ª in which the charge is supported on a bed 24 of broken coke or bricks, supported in turn on a sand bottom 23. The fuel, mixed with air, is supplied through a nozzle 19 and inlet 14, and secondary air enters at 21 from a wind-box 22. By regulating the air and fuel supplies, reducing, neutral, or oxidising gases may be passed to the cupola.

Alloys

THE production of hard metallic compositions consisting of tungsten or a like metal of the chromium group, together with carbon and cobalt or a like metal of the iron group, is described in Patent Application 288,521, bearing the International Convention date April 6, 1927, by the British Thomson-Houston Co., Ltd., of London, assignees of S. L. Hoyt, of Schenectady, New York. A mixture of the powdered materials is subjected to pressure (1,000 lb. per sq. in.) at a sintering temperature (1,300-1,450° C.), *e.g.*, in a space between electrodes. Tungsten carbide may be formed in a preliminary operation by heating the tungsten with finely divided carbon or in methane or lighting gas.

THE production of hard metallic compositions comprising a metal of the chromium group, *e.g.*, tungsten, a metal of the iron group, *e.g.*, cobalt, and carbon, is described in Patent Application 289,477, bearing the International Convention date April 28, 1927, by the British Thomson-Houston Co., Ltd., of London, assignees of E. G. Gilson, of New York. A mixture of the powered ingredients is subjected to pressure (1,000 lb. per sq. in.) at a sintering temperature (1,300-1,450° C.), preferably between electrodes in a carbon mould.

METALLBANK UND METALLURGISCHE GES. AKT.-GES., of Frankfort-on-Main, describe copper-silicon alloys containing one or more other elements such as nickel, iron, manganese, cadmium, tin, chromium, tungsten, zinc, aluminium, magnesium, arsenic, antimony, calcium, cobalt, phosphorus, or titanium, and also up to 10 per cent. of one or more of the metals lead, cadmium, and thallium. See Patent Application 288,974, bearing the International Convention date April 16, 1927.

Iron and Steel

IN Specification 291,717, dated December 24, 1926, F. Siemens Akt.-Ges., R. Durrer, F. C. Siemens, and A. Sprenger, all of Berlin, describe a process for the manufacture of steel in the Siemens-Martin furnace, characterised by the introduction into the furnace, at least from the termination of the fining process, of coal-dust from coal poor in gas (coke, semi-coke, poor coal, etc.), to provide a protective layer over the bath. The coal-dust is preferably blown into the current of heating gas by means of blast-furnace gas. A steel having particularly valuable strength properties is obtained by leaving the charge to stand after the reduction until an extensive separation of impurities has occurred owing to differences in specific gravity.

IN a process for extracting iron from its ores, described in Patent Application 288,319, bearing the International Convention date April 7, 1927, by Vereinigte Stahlwerke Akt.-Ges., of Dusseldorf, a mixture of the crushed ore with an alkali chloride or a chloride of a metal of the calcium or magnesium groups is heated (preferably in an atmosphere of nitrogen) to 150-250° C. until iron chloride is formed. The mixture is then treated with hydrogen at 150-200° C., and the iron produced separated magnetically or otherwise. Alternatively, the iron chloride may be separated from the mixture by volatilisation, freed from water and hydrochloric acid, and treated with hydrogen at 300° C.

To obtain malleable cast iron, a mixture of steel scrap, residues from previous melts, and small quantities of ferro-silicon and ferro-manganese is melted in a cupola to produce a white iron containing not more than 2·90 per cent. of carbon (cementite and pearlite), 1·10-1·50 per cent. of silicon, 0·42-0·75 per cent. of manganese, 0·10-0·20 per cent. of phosphorus, less than 0·20 per cent. of sulphur and 98·38-94·45 per cent. of iron. The product is then embedded in sand or iron ore in an annealing furnace and heated rapidly 20-680° C., followed by 12 hours at 680-730° C., rapid heating to 730-800° C., 12 hours at 800-830° C., rapid heating to 830-880° C., 48 hours at 880-900° C., cooling at the rate of 5-8° C. per hour to 700° C., and thereafter rapid cooling. See Patent Application 288,980, bearing the International Convention date April 16, 1927, by C. E. Kluijtmans, of Brussels, and W. H. W. Procter, of Coventry.

Current Articles Worth Noting

We give below a brief index to current articles in the technical Press dealing with metallurgical subjects.

ALLOYS.—The structure of tin-antimony alloys. W. Broniewski and L. Sliwowski. *Comptes Rendus*, June 11, pp. 1615–1616 (in French).

Aluminium alloys in motor construction. H. Steudel. *Zeitschrift Metallkunde*, May, pp. 165–179 (in German). Possible applications of light metals in motor construction; details of alloys commonly used.

ANALYSIS.—The potentiometric analysis of steel-hardening materials and special steels. II. The determination of chromium and vanadium in ferro-alloys and alloy steels. E. Zintl and P. Zaimis. *Zeitschrift angewandte Chem.*, May 26, pp. 543–546.

BRASS.—The recrystallisation of α-brass. A. Basz and R. Glocker. *Zeitschrift Metallkunde*, May, pp. 179–183 (in German). The recrystallisation of 70/30 and 63/37 brass. Investigation of the influence of the manner and speed of deformation, as well as of the influence of additions of iron and lead. Comparison of the sensitivity of various methods for the indication of the commencement of recrystallisation.

Structural development in brass tubes (surface defects and their avoidance). F. Ostermann. *Zeitschrift Metallkunde*, May, pp. 186–187 (in German). The surface defects occurring when brass tubes are bent are connected with structural development. This is determined by the copper content of the alloy and the nature of heat treatment. The various changes of structure in the production of brass tubes are discussed. Quality tubes should contain not less than 61–61·3 per cent. of copper, and the annealing temperature should not exceed 600° C.

CARBURISING.—Production tests in carburising compounds. J. S. Ayling. *Trans. Amer. Soc. Steel Treating*, June, pp. 1038–1042. A short and inexpensive method of testing the relative merits of carburising compounds under actual production methods as used in any heat treatment department.

CORROSION.—Corrosion phenomena in aluminium bronze tubes and means for their prevention. A. Merz and E. Brennecke. *Korrosion und Metallschutz*, June, pp. 136–140 (in German).

GENERAL.—The tarnishing of palladium on heating in air and on anodic polarisation. G. Tammann and J. Schneider. *Zeitschrift anorganische Chem.*, Vol. 171, Parts 3–4, May 12, pp. 367–371 (in German).

The revelation of internal plastic deformations in a piece of metal. G. Tammann and M. Straumanis. *Zeitschrift Metallkunde*, May, pp. 184–185 (in German).

IRON.—The question of the solubility of oxygen in iron and iron oxide (oxoferrite). C. Benedicks and H. Löfquist. *Zeitschrift anorganische Chem.*, Vol. 171, Parts 3–4, May 12, pp. 231–238 (in German).

Equilibrium investigations in the reduction, oxidation and carburisation processes in iron. VI. The solubility of oxygen in iron. Remarks on the above paper by Benedicks and Löfquist. R. Schenck and T. Dingman. *Zeitschrift anorganische Chem.*, Vol. 171, Parts 3–4, May 12, pp. 239–257 (in German).

The electrochemical action of inhibitors in the acid solution of steel and iron. E. L. Chappell, B. F. Roetheli, and B. Y. McCarthy. *Ind. Eng. Chem.*, June, pp. 582–587. In the pickling of steel or iron, the addition of inhibitors to the acid greatly decreases the rate of attack on the bare metal, but at the same time permits a fairly rapid solution of the scale. It is found that this decrease in metal solution with its accompanying hydrogen evolution is proportional to the increase in cathodic overvoltage caused by the inhibitor. It is suggested that the inhibitive action is due to the formation of a layer of discharged inhibitor substance on the cathode areas.

SINGLE METALS.—Nickel: An account of its alloys and its uses. A. C. Sturney. *Mining Mag.*, June, pp. 341–347.

Some observations on electrolytic copper. W. Köster. *Zeitschrift Metallkunde*, May, pp. 189–191 (in German).

STEEL.—Manufacture of high-strength structural steel for bridges. L. S. Moisseif, H. C. Boynton, A. V. de Forest and A. T. Morris. *Trans. Amer. Soc. Steel Treating*, June, pp. 941–960. Deals with high-strength steel for modern bridges; acid open-hearth steel for suspension cables; silicon structural steel for bridges; and drawn wire and its heat treatment.

Studies on normal and abnormal carburising steel. O. E. Harder, L. J. Weber and T. E. Jeralek. *Trans. Amer. Soc. Steel Treating*, June, pp. 961–1008. Effects of heating normal steel in nitrogen, oxygen and carbon dioxide, and heating abnormal steel *in vacuo* at carburising temperature; of melting normal and abnormal steels under various conditions, etc.

Influence of structure "as cast" upon manufacturing and qualities of some alloyed, especially high speed steels. F. Rapatz. *Trans. Amer. Soc. Steel Treating*, June, pp. 1008–1022. Deals with a constituent of many steels known as ledeburite, corresponding to the eutectic of pig iron. It is shown that there is great variation in the grain size in different parts of an ingot owing to different rates of solidification.

TOOL STEEL.—Effects of antimony, arsenic, copper and tin in high speed tool steel. H. J. French and T. G. Digges. *Trans. Amer. Soc. Steel Treating*, June, pp. 919–940. Effects of above metals when added (not residual) to low-tungsten high-vanadium high speed tool steel. Hot working and machining properties, hardness, and tool performance are considered.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

London Gazette, &c.

Company Winding Up Voluntarily

REX ZAAIPLAATS TIN MINES, LTD. A. J. Culley, 341, Salisbury House, London Wall, appointed as liquidator. June 7.

Mortgages and Charges

*[NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.]*

KENYON (JOHN) AND CO. (SHEFFIELD) LTD., steel manufacturers. Registered May 15, £20,000 debentures; general charge. *£33,039. December 31, 1927.

RICE AND CO. (NORTHAMPTON), LTD., founders. Registered May 22, £10,000 debenture, to Branch Nominees, Ltd., 15, Bishopsgate, E.C.; charged on land at Northampton, etc., also general charge. *——. December 14, 1927.

SHEEPBRIDGE COAL AND IRON CO., LTD., Chesterfield. Registered June 2, £350 and £1,500 debentures, part of £750,000; general charge not including uncalled capital and certain property. *£580,050. October 10, 1927.

SHEFFIELD PREMIER ALLOYS CO., LTD. Registered May 29, £2,000 debenture, to Branch Nominees, Ltd., 15, Bishopsgate, E.C.; charged on land at Sheffield, also general charge. *——. June 30, 1927.

BEARDMORE (WILLIAM) AND CO., LTD., London, S.W., steel manufacturers, etc. Registered June 7, mortgage for £11,000 and further advances (not ex.) therewith £125,000, to Lloyd's Bank, Ltd., Royal Bank of Scotland and National Bank of Scotland, Ltd.; charged on certain moneys payable to company under a contract. *£1,520,457 11s. 8d. January 5, 1928.

WHITEHAVEN HEMATITE IRON AND STEEL CO., LTD. Registered June 16, mortgage to District Bank, Ltd., securing all moneys due or to become due to the Bank; charged on land and buildings at Cleator, etc., also general charge. *Nil. June 30, 1927.

Monthly Metallurgical Section

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NOTICE.—Communications relating to editorial matter for our Monthly Metallurgical Section should be addressed to the Editor, THE CHEMICAL AGE, *Bouverie House, 154, Fleet Street, London, E.C.4. Communications relating to advertisements and other business should be addressed to the Manager. Contributions will be welcomed from correspondents on any points of interest to metallurgists bearing on works practice or current research problems.*

The Composition and Properties of Soft Solders

(From a Correspondent)

LEAD-TIN alloys constitute the basis of most soft solders, which are essentially low-melting point alloys, white in colour and possessing only moderate strength. With modern developments, and the consequent needs for special and more definitely reproduceable results in many applications of soldering, attention has been devoted of recent years to the effect of impurities on the mechanical and thermal properties and on the appearance of the more widely used lead-tin solders, and also to the effect of substituting other elements for tin in substantial proportions. Any metal or alloy which is capable of alloying readily with other metals or alloys and forming satisfactory joints at soldering temperatures may be regarded as a solder. The "wetting" power of any particular metal or alloy also largely determines its success as a solder, but this properly depends also on such factors as fluxes and temperature.

The usefulness of soft solders is governed almost entirely by their composition, which determines other features. The appearance of the alloys is also of importance, and this is governed by a number of factors such as composition, pouring temperature, mould temperature, etc., the appearance being improved by slow rates of solidification. Both the melting temperature and the melting or freezing range of soldering alloys are important, and it is desirable in soft solders that the metal should be very fluid just above its melting range, and that the range should be narrow in order that the metal may solidify rapidly. For wiping solders a reasonable solidification range is essential.

Straight Lead-tin Solders

Of the straight lead-tin solders a great number are used, the highest tin content being about 66 per cent., and the lowest about 30 per cent. These alloys commence to melt at 181° C., which is the melting point of the eutectic alloy of the series, containing about 63 per cent. of tin. The temperature of complete fusion of the alloys of the series, or the temperature at which freezing commences on cooling, varies with the composition, increasing progressively from the eutectic temperature of 181° C. at the eutectic composition to 328° C., the melting point of lead, or, on the other side, to 232° C., the melting point of tin. The freezing or melting range of the 50 : 50 alloy, for example, is 181° to 210° C., and that of the alloy containing 60 per cent. of lead, 181° to 240° C.

Of the lead-tin solders, the composition of those of highest quality—tinsmith's fine solder—is, approximately, that of the eutectic alloy, the standard specification being tin 63 to 68 per cent., and the maximum limits for antimony, iron, arsenic, and zinc, 1·0, 0·2, 0·05 and 0·05 per cent., respectively, the total impurities not to exceed 1·5 per cent. The more usual solders contain approximately equal proportions of lead and tin—plumbers' soft solder—or about two parts of lead to one of tin—plumber's coarse solder. The standard specifications for these are similar to that given above with regard to impurities, but many solders are made and used which contain impurities in excess of these amounts. These are harder than the fine solder of eutectic composition, and have a pronounced solidification range where the alloy is of a pasty consistency, which allows them to be shaped to the joint; hence their suitability for plumber's wiped joints.

For general work solders containing 30 to 40 per cent. of tin and 2 to 3 per cent. of antimony are widely used. The following compositions of the usual grades of lead-tin solders are given in report No. 219 of the British Engineering Standards Association :—

	Tin Per cent.	Antimony Per cent.
1. Work requiring low melting points : Steel tube joints	64–66	0·0–1·0
2. Tinsmiths' and coppersmiths' fine working solder	49–51	2·5–3·0
3. General work	39–41	2·0–2·4
4. Plumbers' wiped joints	29·31	0·7–1·0
5. Special electrical purposes	94–96	0·0–0·4
6. General electrical purposes, zinc and galvanised iron work	49–51	0·0–0·4
7. Tinned electrical joints, zinc and galvanised iron work	41–43	0·0–0·4
8. Lead cable wiped joints	34–36	0·0–0·3
9. Dipping baths	29–31	0·0–0·3

Effect of Antimony

Antimony is usually present in lead-tin solders, and is quite commonly added in amounts up to about 10 per cent. This element has been considered to exert influences of an injurious kind on soldering alloys, but experience has shown that its presence is attended in many cases with definite advantages. In discussing the merits and properties of soft solders, E. T. Richards (*Brass World*, 1927, XXIII, 361) maintains that in solders containing 50 per cent. or less of tin a good appearance of the strip is only obtained by the addition of about 2 per cent. of antimony, and that the addition of this element gives a better appearance to solders containing 43 to 48 per cent. of tin than that of the 50 : 50 alloy without antimony. Antimony hardens and increases the strength of solder, and strengthens the joints made, but the ductility of the alloy is somewhat impaired if excessive amounts of this element are added. Although it also has a tendency to decrease the fluidity of solder and to diminish its adherence to galvanised surfaces, these defects too only become noticeable when relatively large amounts are present.

Where joints are not required to withstand high bending stresses, the antimony may be as high as 3 per cent., and for soldering lead, lead-plated sheets, and black iron sheets, solders containing 7 to 9 per cent. of antimony are used. Many solders of this latter type contain lead as high as 75 to 90 per cent., and tin as low as 15 to 5 per cent.

Commonly-Occurring Impurities

Of the commonly-occurring impurities in lead-tin solders only arsenic and zinc are invariably injurious and harmful. In amounts as low as 0·01 per cent. zinc adversely affects the surface appearance of solder strips, impairs the fluidity and adhering properties of the solder, and weakens the joints, especially after exposure to the atmosphere. It is usual to limit the arsenic content of lead-tin solders to 0·05 per cent., since this element also impairs the mechanical and adhering properties. The chief disadvantages resulting from the presence of copper are its detrimental effect on the appearance of solders, but there are instances, notably in the soldering of zinc alloys, where a relatively high copper content in the solder is regarded as helpful.

Use of Cadmium in Solders

It is now generally recognised that the jointing properties of solders depend on the extent to which they alloy with the base metals, as well as on their adhering properties, and there

seems to be no doubt that in many cases these properties can be obtained in solders containing substitutes for tin. The shortage of this metal in some countries led to the use some years ago of cadmium as a substitute, and since that time lead-cadmium and lead-tin-cadmium solders have been studied and developed, but they have not yet found wide application. Results which have been obtained show that the chemical and mechanical properties of properly applied lead-tin-cadmium solders are quite comparable with those of lead-tin solders. They generally contain a preponderating quantity of lead—about 80 to 90 per cent.—and about 5 to 15 per cent. of cadmium. The darker colour attributed to these solders only becomes apparent when they are compared with lead-tin solders containing 80 to 90 per cent. of tin. According to Richards, an American solder containing 90 per cent. of lead, 7·8 per cent. of cadmium, and 1·4 per cent. of zinc is superior to tin solders in resisting corrosive influences at high temperatures.

A study of the properties of lead-tin-cadmium solders has recently been published by C. E. Swartz (*Brass World*, 1928, XXIV, 74) and the results show clearly that these alloys offer distinct possibilities and advantages as solders. For most soldering work the best composition approximates to that of the ternary eutectic of the series—32 per cent. of lead, 50 per cent. of tin, and 18 per cent. of cadmium—which melts at 145° C. The final soldification temperatures of the various alloy systems encountered in soft solders are given by Swartz as follows :—

System.	Solidification Temperatures. ° C.
Cadmium-Zinc	263
Lead-Cadmium	249
Lead-Cadmium-Zinc	241
Lead-Tin	181
Tin-Cadmium	176
Tin-Cadmium-Zinc	157
Lead-Tin-Cadmium	145
Lead-Tin-Cadmium-Zinc	136

Resistance to Corrosion

It has been suggested that solders containing cadmium are slightly less resistant to atmospheric corrosion than lead-tin solders, but there is not much evidence to show that the difference is very marked. The resistance of a solder containing 80 per cent. of lead, 10 per cent. of tin and 10 per cent. of cadmium to atmospheric corrosion is, according to Richards, equal to that of 50 : 50 lead-tin solder, and according to Eyles the tensile strengths are, approximately, the same. Small additions of zinc—1 to 3 per cent.—increase the resistance of lead-tin-cadmium solders to corrosion, and also improve the strength of the joints. Because of their possession of higher electrical conductivity than that of lead-tin-antimony solders, cadmium solders containing zinc are well suited for electrical work. The addition of zinc also increases the solidification range, lowers the temperature of final solidification, and decreases the tendency to oxidation. Larger quantities of this element are not added, since it is only sparingly soluble in molten lead at soldering temperatures.

Solders containing cadmium and zinc only have been used for certain purposes with some measure of success, notably in soldering aluminium and in soldering cycle framework, since soft solders do not withstand stove enamelling temperatures. Various compositions are used, but that possessing greatest strength is of eutectic composition—80 per cent. of cadmium and 20 per cent. zinc—and is much stronger than lead-tin solders. Alloys of tin and zinc with or without the addition of small amounts of other metals have been tried as aluminium solders. Bismuth is sometimes added to soft solders to obtain a low temperature of final solidification. As well as achieving this object, it increases the fluidity, but it makes the alloys brittle, and, save in exceptional cases, bismuth solders are but little used. In considering the choice of a soft solder, the particular requirements of the work must be borne in mind, and then in the interests of economy the cheapest solder of the type, that is, the solder containing the largest proportion of lead which will yield the desired results, should be used.

M. C.

The Extraction and Applications of Thorium.—(II)

By G. Malcolm Dyson, Ph.D., A.I.C.

In the last Metallurgical Supplement of THE CHEMICAL AGE, *Dr. Dyson, in the first part of this article, dealt with the sources of thorium, its extraction from the ores, and the preparation of the metal. In what follows, the author deals with the properties of the metal and its compounds, and with mesothorium.*

The thorium powder is converted to small bars, by hydraulic pressure, and the bars may be "swaged" under electrical heating. It is, however, usual to fuse the thorium in vacuo (Fig. I). The swaged bar is placed in a thoria dish (obtained by bonding pure thoria with a small amount of cryolite) and heat is induced by the passage of high-frequency alternating current through the coil, which is enclosed in an evacuated quartz bulb. About 10 turns of 60-mil tungsten wire wound on a ¾ in. mandrel is sufficient. The wire and ingot are degassed by passing a 200 volt D.C. current through the coil and maintaining the coil and charge at a bright red heat for several hours. The degasified thorium is very active and takes fire in oxygen, while even the admission of hydrogen to the bulb causes the metal to become red-hot. The metal so obtained is malleable, and assays at 99·5 per cent. purity. It may best be examined by polishing and photomicrography, when the oxide is immediately visible as small grey specks and the silicide as hard white striæ. The general properties of this pure thorium are :—

Density	11·3–11·7.
Melting point	1842 ± 30 C.
Specific resistivity	18×10^{-6} ohms per cc./20° C.
Expansion	0·00017 between 0–100° C.
Hardness	73 (Rockwell machine), *i.e.*, comparable to brass or cold-worked copper.
Tensile strength	80,000 lb./sq. in.

One of the most important properties of thorium is its electron emission power. This quality (shown graphically below in Fig. II) has led to its use not only in radio-construction, where it increases the valve efficiency, but also in the manufacture of targets for X-ray tubes. It gives more total X-radiation than does tungsten under the same circumstances and, moreover, gives a greater proportion of K radiation, which, of course, means that deeper penetration can be obtained.

Thorium Compounds

The industrial uses of thorium compounds fall into two classes : the use of thoria, mixed with other rare earth oxides, as the incandescent matter of the Welsbach gas mantle, and the use of thoria as a dehydration catalyst. The former

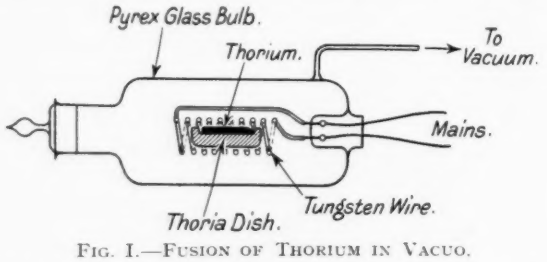


FIG. I.—FUSION OF THORIUM IN VACUO.

outlet disposes of by far the larger amount of thorium, since all mantles whether of ramie or artificial silk are impregnated with thoria. The mixture used contains : Thorium nitrate, 1,000 parts ; cerium nitrate, 10 parts ; beryllium nitrate, 5 parts ; and magnesium nitrate, 1·5 parts. It is allowed to act for two minutes only on ramie or cotton mantles, but for longer (five hours) on artificial silk. The impregnated mantles are dried at 30° C., and the name of the manufacturer stamped

on them with a solution of didymium nitrate, glycerol and methylene blue, the didymium serving to decrease the luminosity and so throw up the design in relief. The final stage consists in dipping the impregnated mantles into a bath of collodion or cellulose acetate solution, in order to protect them against the shocks of transport. It need scarcely be added that for nitrocellulose artificial silk mantles a denitrating sulphide bath must be incorporated in the process. The emissivity of heated thoria is also utilised in the production of thoria "limes" for searchlights, the quality of the light emitted being better than that of lime, while the extremely refractory nature of thoria enables the thoria cylinders to be used for a longer period than is possible with lime itself.

We owe the use of thorium as a catalyst in the dehydration of organic compounds to the work of Sabatier, Senderens, and Maihle. Two classes of compounds are amenable to dehydration in this way—by passage over heated thoria—namely, acids, which give rise to ketones, as, for example, butyric acid which gives butyrone :—

$$\begin{matrix} CH_3.CH_2.CH_2COOH \\ + \\ CH_3.CH_2.CH_2COOH \end{matrix} \rightarrow \begin{matrix} CH_3.CH_2.CH_2 \\ \\ CH_3.CH_2.CH_2 \end{matrix} \!\!>\!\! CO + CO_2 + H_2O$$

and alcohols, which give unsaturated hydrocarbons. Of this latter dehydration, the preparation of amylene from amyl alcohol is a good example :—

$$CH_3.CH_2.CH_2.CH_2.CH_2.OH \rightarrow CH_3.CH_2.CH_2.CH=CH_2+H_2O.$$

These two reactions are conducted on a large scale in the manner indicated.

Mesothorium

Mesothorium is an interesting by-product obtained in the extraction of thorium, and is valuable in providing a comparatively cheap substitute for radium as a source of phosphorescence in the so-called luminous paints. To obtain the mesothorium, the process followed out is that of adding a few pounds of barium chloride to each ton of crude thorium oxide before converting to the sulphates. Mesothorium is precipitated along with the barium sulphate slimes, and may be extracted by processes similar to those described in a previous article in this series (THE CHEMICAL AGE, 1927, October, p. 25). under "Radium." Mesothorium is much cheaper than radium, but it suffers from certain disadvantages when compared with that element. In the first place, its half-life period is only 5½ years, so that it can only act as a source of energy for a comparatively short period. This, however, is not a serious drawback in the case of the cheaper watches

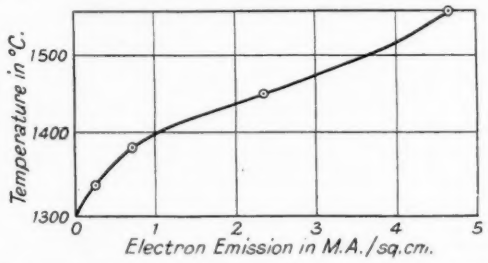


FIG. II.—ELECTRON EMISSION POWER OF THORIUM.

and clocks, etc., which are rarely expected to last for more than a few years. The second disadvantage is in the fact that mesothorium must be "ripened," before use about 18 months. The simple degradation of mesothorium produces only β-rays, which are useless for exciting luminescence, this phenomena being due to effect of the α-rays ; the mesothorium changes, however, to radiothorium, which gives the necessary α particles in due course, but until sufficient radiothorium has accumulated, the mesothorium is of no value for purposes of luminescence.

Baldwin's Capital Reduced

MR. JUSTICE MAUGHAM, in the Chancery Division, on Monday, had before him the petition of Baldwins, Ltd., the coal, iron, steel, and tinplate company, for sanction to a reduction of capital from £8,000,000 to £4,213,568 2s., and to a scheme for the rearrangement of capital as between the debenture stock-holders and shareholders, and Lloyds Bank, who are large creditors. The scheme was approved.

Institute of Metals Meeting

Final Arrangements

ABOUT 200 persons have already indicated their intention of taking part in the autumn meeting of the Institute of Metals at Liverpool, in the period September 4 to 7, and a formal programme has now been issued. The main arrangements have already been announced. The Autumn Lecture will be delivered by Mr. F. G. Martin, B.Sc., F.I.C., the subject being "Non-Ferrous Metals in the Shipping Industry." Among the works visited will be those of Lever Bros., Ltd. ; High Speed Steel Alloys, Ltd. ; Thos. Bolton and Sons, Mersey Copper Works ; and the Penpoll Tin Smelting Co., Ltd. There will be a trip into Wales, visiting Bettwys-y-Coed and Dolgarrog.

Papers to be Read

The following communications are expected to be submitted at the meeting : Smithells, C. J., D.Sc., S. V. Williams, B.Sc., and J. E. Avery, B.Sc., D.I.C., "Laboratory Experiments on High Temperature Resistance Alloys" ; Evans, U. R., M.A., "Corrosion at Discontinuities in Metallic Protective Coatings" ; Gwyer, A. G. C., B.Sc., Ph.D., H. W. L. Phillips, B.A., and L. Mann, "The Constitution of the Alloys of Aluminium with Copper, Silicon and Iron" ; Jones, W. R. D., M.Sc., "The Copper-Magnesium Alloys. Part III" ; Brook, G.B., F.I.C., and H. J. Simcox, B.Sc., "Note on Practical Pyrometry" ; May, R., A.R.S.M., "Eighth Report to the Corrosion Research Committee. The Corrosion of Condenser Tubes. 'Impingement Attack,' its Cause and Some Method of Prevention" ; Malam, J. E., "The Rockwell Hardness Test" ; Russell, T. F., Assoc.Met., W. E. Goodrich, B. Met., W. Cross, B.Sc., and (in part) N. P. Allen, M.Met., "Die-Casting Alloys of Low Melting Point" ; Hargreaves, F., A.R.S.M., D.I.C., F.I.C., "Work-Softening of Eutectic Alloys" ; Genders, R., M.B.E., M.Met., F.I.C., R. C. Reader, Ph.D., M.Sc., and V. T. S. Foster, M.Met., "Die-Casting of Copper-Rich Alloys" ; Smith, C. S., D.Sc., "The Alpha Phase Boundary of the Copper-Silicon System" ; Archbutt, S. L., J. D. Grogan, B.A., and J. W. Jenkins, Ph.D., "Properties and Production of Aluminium Die-Castings" ; Hume-Rothery, W., Ph.D., M.A., "Methods for Investigating Alloys of Reactive Metals" ; Jenkins, C. H. M., B.Sc., A.R.S.M., "The Strength of a Cadmium-Zinc and of a Tin-Lead Alloy Solder" ; and Tullis, D. R., "Note on the Treatment of Aluminium and Aluminium Alloys with Chlorine."

For further information with regard to the meeting, application should be made to Mr. G. Shaw Scott, secretary, The Institute of Metals, 36, Victoria Street, London, S.W.1.

Publications on Nickel

A STEADY stream of publications regarding nickel continues to appear. The Bureau of Information on Nickel has just published a pamphlet which is an illustrated general survey of *Nickel and Nickel-Chromium Steels*—Part 1, Low Nickel Steels—forming an introduction to a series of technical pamphlets which the Bureau will issue on this important subject. The Mond Nickel Co., through its research and development department, has issued a neat loose-leaf binder containing various publications of the department, having room for the insertion and indexing of future publications. The articles contained at present are : "Position of Nickel in Modern Metallurgy," by W. R. Barclay ; "Common Defects in Nickel Deposits : Their Occurrence, Cause and Elimination" ; "The Nickel-Copper Alloys Containing Less than Fifty Per Cent. Nickel" ; "The Nickel-Copper Alloys Containing More than Fifty Per Cent. Nickel" ; "The Physical Properties of Nickel-Iron and Some Related Alloys" ; and "Case-Hardening and the Use of Nickel Steels." The binder gives facilities for filing publications under a number of headings.

Beginning also with the month of July, the Mond Nickel Co.'s research and development department has begun the issue of a monthly bulletin (*The Mond Nickel Bulletin*) which contains abstracts of all references to nickel of technical interest. In addition, some aspect of the metallurgy of nickel and its alloys will be dealt with more fully each month. In this way it is hoped to draw the attention of the recipients to published information on nickel as soon as it is available.

Metallurgical Topics: Monthly Notes and Comments
From Our Own Correspondents

Nitrogen in Steel

NITROGEN is one of the most inert of the elements, and, before X-ray analysis had elucidated lattice structures and shown how the presence of stranger-atoms can stiffen the framework, might have been anticipated as influencing but little the properties of iron and steel. By analogy, however, with its companion elements in the periodic system, such influence as it might exert would be similar to that of phosphorus, arsenic, antimony or bismuth, and even stronger, seeing that it is the most electro-negative of the group. Since Braune's researches on the subject, its presence has been regarded as noxious, and the cause of brittleness in mild steel. It is probably an invariable constituent of commercial iron and steel, and particularly of Bessemer steel, but it is difficult to estimate, and there are numerous cases where, even if present, it is likely to escape detection. Acicular needles of iron nitride have been described by many observers, and Svetchnikoff has published tables showing the amounts present in various grades of material. Other things being equal, high-carbon steels contain less nitrogen than mild steels. In high-manganese Bessemer steel rails (Mn. 0·93 per cent.). Tchijevsky found 0·015 per cent. of nitrogen; electric steels made in induction furnaces are, according to other observers, rather more contaminated than those made in arc furnaces, and high grade Swedish iron contains traces only (0·0029 per cent. of nitrogen). Steel made in small converters was found by Freuheit to contain as much as 0·02 per cent. after decxidation, although rather less before.

Liquation of Nitrogen in Iron

IT is fairly well established by now that the presence of nitrogen conduces to brittleness, and Stroymeyer, many years ago, incriminated the element on the cause of otherwise mysterious boiler plate failures. Svetchnikoff has collected a number of instances within his own knowledge where this embrittling effect has been due to as much as 0·026 per cent. of nitrogen, which betrays itself by the presence of the acicular needles of iron-nitride (Fe_4N), which commence to appear once the percentage of nitrogen exceeds 0·015 per cent. That more is not found may, in many cases, be due to analytical difficulties; the sampling requires to be carried out with extreme care owing to the tendency of the nitrogen to segregate. Indeed, as Svetchnikoff brings abundant evidence to prove, liquation is an invariable phenomenon accompanying the presence of nitrogen in commercial iron and steel. He found the evidence particularly strong in the case of certain overblown samples of converter metal. The amount of the element present in different parts of an ingot varied 92 per cent.; the highest individual percentage he records was 0·042 per cent. of nitrogen. He concludes that the conditions under which nitrogen segregates are identical with those under which phosphorus segregates, and that when both elements are present their tendency to liquate is increased and the results intensified.

Case-Hardening by Nitrogen

THE fact that nitrogen embrittles iron and steel is not contested, and as britleness is but a manifestation of hardness it is not surprising to find that many attempts have been made to employ nitrogen as a hardening medium for iron and steel. It may be that in cementing and case-hardening iron with cyanides, the nitrogen plays its part *parri passu* with the carbon. Case-hardening by nitrogen has been the subject of numerous experiments, and renewed interest has been taken in the subject since it has formed the basis of several patents recently applied for by Krupps (for example, B.P., 287,156, 1928). The British patent specifications are not very explicit, but from time to time the Krupp experiments with nitrogen have been described in the German technical papers, and the broad outlines are fairly well-known. Most of the work has been carried out by A. Fry. The process is more particularly applicable to the case-hardening of small steel parts which it is desirable to preserve carefully from all distortion. The process is carried out, therefore, at the comparatively low temperature of 580° C., and the case-hardening and nitrogen-yielding medium employed is a gas consisting chiefly of ammonia. Heating is continued for a considerable time (40 to 60 hours) but, while the case is satisfactorily hard, it is said not to be brittle, as the temperature is below that at which the noxious nitrides (Fe_2N and Fe_4N) form; and the equally noxious iron nitride eutectoid (Braunite) with which, according to Fry, the objectionable brittleness is chiefly associated, is not found in the finished and case-hardened article. The case is glass-hard and greyish in appearance when the articles are withdrawn from the furnace, but it is easily polished and retains a high surface finish. The process is applicable to parts which it would be difficult or impossible to carburise in the ordinary way.

Case-Hardening Alloy Steels

APART from the Krupp experiments, a good deal of work on the subject of case-hardening by nitrogen has been done in France by L. Guillet. He has met with very satisfactory results in all cases in which the steels experimented with contained aluminium, which he seems to regard as specially favourable to the process he employed. He used chromium, silicon and molybdenum steels, and by cementing for four days obtained cases up to 0·8 mm. thick, and extremely hard. He used ammonia as an atmosphere, and a lower temperature than that at which Fry carried out his work, as in the French experiments the furnace was maintained round about 500 to 510° C. Guillet's work implies that the presence of aluminium, chromium, silicon, and molybdenum prevents the diffusion of the gas into the metal, and confines the action to the surface, where it forms nitrides. Fry, on the other hand, has, as we have seen, claimed that these nitrides do not form, and that it is to their formation in other processes, and the formation of their eutectic with the iron, that the brittleness complained of is to be attributed.

Impurities in Metals

DR. SMITHELLS' latest book (*Impurities in Metals*: Chapman and Hall, 18s.) will be welcome to metallurgists. Their only quarrel with the author will be that he has hardly dealt at sufficient length with his fascinating subject. The literature is vast and is daily growing, and the facts which are accumulating are badly in need of co-ordination. Dr. Smithells is not, of course, concerned with the general question of the influence of various metallic elements on one another, but only with that of very small amounts of impurities. In other words he is dealing with the subject reciprocal to that of purity of metals, in the modern sense. When all the facts have been fully sorted out, certain generalisations will doubtless emerge. At present it is too early to generalise, and Dr. Smithells has wisely avoided all attempts to do so. Thus, he gives examples of the effects which accompany the presence of small quantities of metallic constituents, but emphasises the fact that one impurity may influence another. Thus their effects may either tend to counteract or to reinforce one another. We are very far, as yet, from being able to deduce a plain story from the facts in our possession, but there is every reason to believe that in the near future we shall be able to connect qualitative effects definitely with quantitative causes, and predict, in all certainty, the physical properties of a metal from an accurate knowledge of all its constituents. The key to the enigma will be the lattice structure, and the extent to which it can "house" minute traces of foreign matters. Dr. Smithells is right, therefore, in devoting what might be otherwise regarded as almost an unnecessary proportion of his space to giving the broad general principles required to understand what a lattice structure is, and how it can be studied.

Mechanical Properties of Atoms

PRACTICALLY nothing is known of the mechanical properties of atoms, but only of aggregates of atoms built up into a lattice. In these circumstances there is a tendency to derive the properties of materials from what we know, or can guess, of the bonding matter of crystals, plus what we are daily learning as to the properties of single crystals themselves. We had, until the advent of X-radiology, begun somewhat to despair of learning much about the atoms themselves,

and even now there persists a tendency to ignore their existence and intrinsic properties, and to focus only on the behaviour of the aggregate. This may be considered the most immediately practical thing to do: the only objection is that the conclusions are by no means necessarily final. We cannot expect a complete explanation from the investigation of facts which leave out such vital considerations as the properties of the atoms themselves. Hardness, ductility, conductivity, and the host of other properties, physical and mechanical, upon which the behaviour of our materials depends can hardly be exclusively those of the aggregates: the atom itself must count for much. A few years ago such speculations might have been regarded as metaphysical quibblings, but they are much more than this to-day.

The spectrum will probably endow us before long with instruments of observation and measurement of the same order as those hitherto newly employed to investigate crystal structure, but "fine" enough to serve the same purpose in the investigation of atomic structure, properties, and behaviour. The study of the effect of spectroscopically minute traces of impurities will let in a great deal of light on this field of investigation, for such minute and diffused impurities probably function as atoms, and their behaviour will, therefore, help to teach us what atoms really do, and are, and what their individual properties are. When this occurs, metallurgy will have become an exact science, and the clue will have been the study of the minute traces of impurities which at present appear to have erratic and wholly unaccountable influences.

Metallurgical Matters in Parliament

Mr. Dixey (House of Commons, July 16) asked the Prime Minister whether, in view of the demand in the country for the safeguarding of British iron and steel goods, he would consider giving time for the motion standing in the names of certain hon. Members at present on the order paper on this subject: "That this House, whilst appreciating the relief given generally to productive industry by the Government's rating proposals, nevertheless would urge upon the Government the necessity of saving the iron and steel trade in this country by the immediate application of a safeguarding measure to this important basic trade." Mr. Dixey said that 200 members were in favour of the discussion.

Sir A. Chamberlain stated that in view of the state of Parliamentary business, the Prime Minister could not give special facilities for the discussion of the motion referred to.

On Monday, July 23, a deputation of Conservative M.P.'s waited on the Prime Minister to plead for the appointment of a committee to consider the safeguarding of the iron and steel industry. They presented a memorial on the subject bearing the signature of nearly 200 M.P.'s. Mr. Baldwin was unable to hold out any hope of immediate action.

The Midland Laboratory Guild

The Midland Laboratory Guild (1928), Ltd., has been registered as a company limited by guarantee and not having a share capital, with 20 members, each liable for £50 in the event of winding up. The objects are to promote, maintain, and control research and other scientific work in connection with the ferrous or non-ferrous trade or industry, also any other metal trade or industry, to establish, form, equip, and maintain chemical, metallurgical, physical, and mechanical laboratories; to carry on the work of chemical and metallurgical chemists, and the physical and mechanical examination of metals and alloys, etc. The management is vested in the board of directors, the first members of which all reside in Birmingham or district, their names being: A. H. Wolseley, G. Parsons, W. H. Henman, J. H. Allen, W. H. Williams, F. W. Wharton, G. H. Dugard, W. F. Watkins, and C. C. Bamford.

Fishing for Tin

If all goes well a new kind of fishery will shortly be established in the estuary of the Fal, namely a tin fishery. Those who are connected with the venture, which has quite a romantic flavour about it, believe that vast fortunes lie buried in the deep mud of the famous harbour only waiting to be won. From time immemorial tin mines have been worked in the watersheds of the streams which discharge themselves into the Fal estuary. The streams which there join the sea have for hundreds of years brought down with them in suspension tiny particles of tin, which have been deposited in the mud of the estuary. There are millions of tons of this silt in the harbour, and samples which have been taken and submitted to analysis are said to show that it contains tin in what are declared to be good paying quantities. The proposal is to recover these tin particles by an elaborate system of dredging and separation. There is plenty of raw material, in the shape of metalliferous mud, to keep the "fishers" employed for a long time, and it is proposed first of all to tackle a huge bank of mud, some two miles in length, which lies in what is known as Mylor Pool. The tin-containing deposits in it vary in depth from some eight feet to about 100 feet, and when this tin-bearing mud has been dredged it will be taken ashore for treatment. The tin particles are finer even than the particles in cement, and hitherto they have eluded every process of a mechanical or chemical kind applied to them for the purpose of their recovery.

Aluminium Powder

Aluminium powder is coming into increasing use for a great variety of purposes, and the publication of a pamphlet on the subject by the British Aluminium Co., Ltd., is very opportune. Probably the largest use of the powder is for the production of metallic paint, either in its natural state or tinted with aniline dye or other suitable medium to obtain gold, bronze and other effects—so-called silver paint is usually merely bright aluminium paint. As the many remarkable properties of this paint become more widely known, its use for industrial purposes is likely to increase. Already its applications are manifold. Its possibilities as a decorative medium are obvious. As a protective coating also it has many valuable properties, since it is unattacked by sulphur or chlorine, and, moreover, is electropositive to all common metals, which prevents excessive corrosion of the metal underneath at points where the paint may have been chipped off.

The high reflective powers of aluminium paint, not only to light waves, but also to heat waves, have resulted in its extensive use in hot, sunny countries for painting oil storage tanks, refrigerators, etc., and result in a considerable reduction in, *e.g.*, the amount of oil which evaporates. In a similar way, heat losses by radiation from boilers, furnaces, steam pipes, etc., may be considerably reduced by the use of the paint. All these points, as well as the technique of mixture and application of the paint, are discussed at length in the pamphlet.

Aluminium powder has a number of other important uses. Owing to the affinity of the metal for oxygen and high heat of combustion, it may be used as a component of explosives, by mixing the powder with an oxygen-carrying medium such as ammonium nitrate, and these same properties have led to the use of the metal in alumino-thermics, for the production of high localised temperatures for welding rails, etc. By means of the calorising process, aluminium may be incorporated in the surface layer of metals to protect them from corrosion. This informative pamphlet (No. 306) may be obtained from the British Aluminium Co., Ltd., Adelaied House, King William Street, London, E.C.4.

A Mercury Cartel

It is reported that Spanish and Italian producers of mercury will in future dispose of their product through a common sales bureau. This seems to be the closest connection possible between the two groups, since both are more or less under state control. It is suggested that the bureau may be situated in London, as this would be the most reasonable arrangement, and that in this case the "cartel" may work in conjunction with important British interests, as was formerly the case with the Spanish mercury interests, which disposed of their product through Rothschild's.

Chromium Facing of Photo-Engraving Blocks

At the seventh International Congress of Photography, held recently in London, Mr. A. E. Ollard read a paper dealing with the advantages of the chromium facing of copper etched blocks as a means of economy in long runs of illustrated printing. Whereas the life of an ordinary copper block is of the order of twenty to thirty thousand pulls, a chromium-faced half-tone block has been found to give as many as 167,000 pulls without any sign of deterioration. A special advantage is that the chromium facing can very simply be removed and renewed if required. Since this chromium-facing process can quite easily be operated in any photo-mechanical workshop it is a method that obviously demands consideration.

Trade, Commerce, Finance: The Month in Review

From Our Market Correspondent

WITH the advent of the holiday season, which now appears to be in full swing, there has been the customary lull in the iron and steel trade. This holiday break has become established as a seasonal influence which interrupts the normal flow of trade, although one cannot altogether avoid the suspicion that it is often quoted as an explanation of slackness in trade which would have been very little less marked if there had been no holidays. In most districts it is usual for the individual works to close down for a week or ten days for the annual holiday and repairs, but when business is comparatively quiet, as it has been for some months, this short interruption does not have much effect. In fact, it is welcomed by many works as it not only gives an opportunity of clearing up arrears of repairs, but also to accumulate a sufficient weight of orders to make the starting-up period one of increased activity.

Holidays or no holidays, trade has been quiet during the past month, and it is not likely to change for some weeks to come. Indeed, there is no certainty of an improvement in the autumn. It will no doubt then be a little better than at present, but one cannot find any sufficient reason to expect a decided change. Until the causes of the unsatisfactory state of the iron and steel trade are removed, it is useless looking merely to the seasons of the year to find a remedy for the trouble.

Safeguarding Ruled Out

It can now be taken as quite definite that safeguarding is ruled out for at least a year, possibly more; therefore the steel makers are still left to their own resources to meet the competition from abroad and to find the markets which will keep the plants in full operation. The prospects of doing this are not bright. Foreign competition is likely to continue in force as the margin in prices is too great to be bridged by our steel makers unaided. There have been, and will continue to be, occasional increases in Continental prices, but they have very little effect on the general situation here as they are not sufficiently great to cause much diversion of business.

An effort is being made in this country to secure a larger share of the world's export trade by a co-operative scheme which has just been put into force among certain of the steel-producing districts, but the prices which will have to be quoted to make the scheme effective will be so low that it is doubtful whether any actual benefit will accrue. On the other hand, production costs are not likely to decrease. The price of fuel is at a very low level, and any further movement will certainly be upwards. Already blast furnace coke is slightly harder in price, and coal prices will advance as soon as the collieries recover their lost ground, as they are bound to do before very long. Meanwhile there is no reduction in the productive capacity of the steel works.

The Question of Reorganisation

Financial reorganisations seem to be the order of the day, but they do not touch the main problem, which is either to secure better prices for the orders which are available, or, by cheapening costs, to secure sufficient orders even at present prices so as to make these prices profitable. Minor economies can be effected when the financial condition becomes unduly strained, but so long as the determination is persisted in to find work for all the plants, losses will continue to appear in the balance sheets, because the only means of securing the additional orders necessary for anything like full-time operation is to cut prices below those of other makers; and the present level is too low for most makers to meet.

This price cutting can only apply to the uncontrolled products, but these form such a large proportion of the iron and steel production that it has a very important effect on the financial results. As far as the controlled products are concerned, little can be done in the way of increasing the share of the individual works, because consumers realise that there is no advantage in price among the different works, and established preferences will continue to operate as the deciding factor in the distribution of the orders for these classes of materials.

Examples of the result of this struggle for orders have been seen, in too great a number, in the various reconstruction proposals that have been put forward by companies in distress. The latest example is that of the Partington Iron and Steel Co., and its controlling company, Pearson and Knowles.

Output

There still seems to be a conviction in some quarters that output is the only thing that matters, and that so long as sufficient orders are obtained to run the mills at full speed, the cost price will adjust itself to the current selling price. Unfortunately, neither object is achieved. The works are not kept fully employed, and selling prices continue to be less than cost, so that in many instances an increase in orders has meant an increase in losses. Then comes the financial upheaval, and when shareholders have agreed to the loss of capital and the renunciation of rights the game starts again, and the struggle for existence amongst the various makers loses none of its intensity. The lesson is being learned, but very slowly, that if a mill or a section or a whole works cannot operate without incurring losses, the sooner it goes out of operation the better for the industry as a whole as well as for the individual owners.

Rating Relief

Having definitely turned down the request for safeguarding, the Government have offered some encouragement by promising that the reduced railway rates for coal for the iron and steel trade, through the operation of the Rating Relief Act, shall come into force on December 1 this year. This is a relief, but only a small one. Various estimates of its value per ton have been given, but the actual amount will not materially lighten the burden. Moreover, one can foresee that ultimately very little even of this benefit will remain with the steel makers. As soon as it is known that there is a reduction in cost, the consumer begins to clamour for a reduction in the price charged to him, and so urgent is the need for orders that such a demand will always find some maker ready to respond in the hope of securing an advantage over his rivals, the result being that eventually the whole trade has to follow suit.

This, again, illustrates the weakness in the association scheme of control in the steel trade. It is all very well to control certain sizes of plates, bars, and sections, but so long as a large proportion of these materials remains outside the authority of the association, so long will there be this intense competition amongst the home works for this portion of the trade, which, by the way, forms the means of offering inducements to obtain more orders for the controlled materials.

Market Conditions

The actual market conditions during the past month do not call for much comment. In the Midland area the acute competition has been continued, but the low prices which have been accepted have not produced any expansion in business, as the foundries are not busy. Conditions in the Cleveland district are still very unsatisfactory, and there is no sign of a revival. Generally speaking, output still exceeds demand, and it is likely that more furnaces will be put out of commission.

There has been no alteration in the official prices of steel, which remain at £7 17s. 6d. for sections and £8 12s. 6d. for plates. In the uncontrolled material there have been some slight reductions, although boiler plates have suffered considerably, due to active competition from Scotland and South Wales. In semi-finished steel there has been a little better business, owing to the increase in Continental prices. Most of the steel works are only partially employed, and are likely to remain so, as there is a reduction in the work given out by the railways, and the motor trade will be quieter in the next few months.

The production of pig iron in June amounted to 563,700 tons, compared with 591,500 tons in May, the number of furnaces in blast being seven less at the end of the month than at the beginning. Steel production amounted to 709,500 tons, compared with 752,700 tons in May.

Some Inventions of the Month

By Our Patents Correspondent

***Abstracts of other Patents of metallurgical interest will be found in our Patent Literature published weekly in* THE CHEMICAL AGE.**

Alloys

IRON-BERYLLIUM alloys are improved by a quick cooling in air or by quenching from above 550° C., followed by heating to 250-500° C. The beryllium content is not above 13 per cent., and up to 40 per cent. of aluminium, nickel, copper, tin, zinc, cobalt, carbon, or silicon may be present. See Patent Application 288,579, bearing the International Convention date April 12, 1927, by Siemens & Halske Akt.-Ges., of Berlin.

MAGNETIC alloys containing 30 to 80 per cent. of nickel, 20 to 70 per cent. of iron, and 1 to 20 per cent. of silicon are described in Patent Application 290,658, bearing the International Convention date May 20, 1927, by Siemens und Halske Akt.-Ges., of Berlin. In an example the alloy contains 78·5 per cent. of nickel, 17·5 per cent. of iron, and 4 per cent. of silicon. Annealing is effected by heating to about 900° C., cooling slowly to about 625° C., maintaining at that temperature for some time, and finally cooling in air.

H. C. HALL AND T. F. BRADBURY, of Derby, have taken out a patent of addition based on their Specification 281,912, which describes and claims an alloy containing 0·05 to 0·4 per cent. of chromium, 0·2 to 1·5 per cent. of nickel, 0·1 to 1 per cent. of magnesium, up to 0·5 per cent. of antimony, up to 0·5 per cent. of titanium, 0·2 to 1·5 per cent. of silicon, 0·7 to 1·5 per cent. of iron, 2 to 5 per cent. of copper, and the remainder aluminium. The improvement comprises hardening and enhancing the tensile strength of castings made from the alloy by raising the temperature to 160 to 190° C., maintaining that temperature for at least 20 hours, and then quenching. The process has advantages over the usual tempering methods as regards low cost of the heat treatment and the avoidance of distortion, breaking or sagging due to the use of temperatures approaching the melting point of the alloy. See Specification 292,407, dated November 5, 1927.

Concentrating Ores

CERTAIN low-grade ores, such as cassiterite tin ores and minerals containing silver, gold, platinum and other rare metals, are difficult to concentrate either by gravity or flotation processes. According to Specification 292,832, dated November 7, 1927, by R. Anthoine, of Brussels, such ores are first subjected to the action of a reducing gas, such as lighting gas, producer gas, or coke oven gas at a suitable temperature (300 to 900° C.), and are then concentrated by flotation. Only a partial reduction is necessary in most cases.

Iron

A CAST iron alloy containing 1-4 per cent. of carbon, 0·5-2·5 per cent. of silicon, and up to 1 per cent. of molybdenum, in which sulphur, phosphorus and manganese may be present as impurities, and also such metals as chromium, vanadium, or copper, if these are constituents of the scrap used, is described by the Molybdenum Corporation of America, of Pittsburg, U.S.A. assignees of H. L. Greene, of Toledo, Ohio, and C. Taylor, of Pittsburg, in Patent Application 289,075, bearing the International Convention date April 21, 1927.

STEEL or any desired steel alloy is obtained directly from titaniferous ores or iron sands as follows :—The ores, etc., are first subjected to magnetic separation, the concentrate then supplied, together with the requisite reducing agent, to an electric furnace, and the temperature of the bath during the main portion of the reducing operation so controlled so as not to exceed 1,600° C., so that the titanium oxide passes mainly or wholly into the slag. The molten metal, separated from the slag, is then refined to any desired carbon content, and, by addition of carbon with or without one or more alloying elements, converted into the desired steel or steel alloy. See Specification 290,442, dated May 18, 1927, by F. A. de Silva and C. G. Carlisle, of the Anglo-American Steel Co., Ltd., of 66, Victoria Street, Westminster.

A PROCESS for obtaining "solid-produced" (*i.e.*, produced without a melting stage) iron was described in Specification 284,040 (see THE CHEMICAL AGE, Vol. XVIII, p. 23 [Metallurgical Section]), and applications of this process to the production of iron for subsequent use in making steel are now described in Specifications 290,317 and 290,318, dated January 5, 1927, by J. W. Hornsey, of Norton, near Sheffield. The invention, according to Specification 290,317, comprises the step of effecting such a degree of reduction of a phosphorus-containing ore as will ensure a proportion of unreduced iron oxide remaining in the iron sufficient to prevent the mechanically admixed phosphorus from becoming released in elementary form during the manufacture of the steel, and thus deteriorating the product. A small proportion of iron oxide may be added, if necessary, to compensate for a deficiency. The invention, according to Specification 290,318, comprises the step of rendering the iron free from chemically combined sulphur by mixing with the ore a small quantity (about 5 per cent.) of material—*e.g.*, lime, adapted to combine with the sulphur, and to cause it to remain in the slag of the subsequent steel-making process.

A GREY cast iron of high tensile strength is produced by adding to a white or mottled cast iron after it has been tapped from the furnace one or more of the elements aluminium, silicon, nickel, and manganese, to induce the formation of graphite. See Patent Application 290,267, bearing the International Convention date May 13, 1927, by the International Nickel Co., of New York.

Nickel

A PROCESS for refining nickel and nickel alloys in such a manner as to free them from carbon and from gases is described in Patent Application 290,647, bearing the International Convention date May 19, 1927, by the International Nickel Co., of New York. The nickel-containing metal is melted with addition of nickel oxide, any carbon present being thus completely oxidised, and the carbon monoxide is boiled out of the metal, after which the nickel oxide is reduced by a deoxidiser, such as silicon, which does not form gaseous oxides. Manganese is added, if necessary, and the usual magnesium treatment may be effected before casting the metal.

Reducing Ores

A METHOD of reducing ores, specially adapted for producing spongy iron from fine iron ores, is described in Specification 291,822 (Fairweather), dated January 31, 1927, a communication from Nybergs Grufaktiebolag, of Smedjebacken, Sweden. The ore, loaded on trucks, is passed through a channel furnace comprising the following successive zones :—(1) A preheating and roasting zone where the ore is strongly heated and desulphurised by combustion of gas with excess of air ; (2) A pre-reduction zone supplied with reducing gases containing carbon monoxide ; (3) A main reduction zone through which the reducing gases are also passed. These gases are regenerated by incandescent fuel in a recarbonising furnace, the excess of gas formed in the circulation system being wholly or partly supplied to the pre-reduction zone and then to the roasting zone. The ore is preferably mixed with pulverulent charcoal or sawdust to increase its porosity when roasted.

IN a process for smelting ores described in Specification 293,109, dated March 29, 1927, by F. Hofmann, of Breslau, Germany, the usual coke or coke plus anthracite is replaced by caking pit coal which has been briquetted at an increased temperature and semi-coked.

Separation of Tin and Lead

A MIXTURE containing oxides of tin and lead is fused at 380° to 450° C. with caustic alkali for about two hours with constant stirring, preferably with addition of 5 per cent. of granular wood charcoal. Most of the tin is then present in the melt as stannate, and a small amount of the lead as plumbite. The latter is removed by treating the melt with a small quantity of water or lye, and lead is recovered from the solution by known means. The tin salts are then extracted from the residue by water, and the tin is recovered from the extract by known means. See Patent Application 290,628, bearing the International Convention date May 18, 1927, by Huttenwerke, Trotha Akt.-Ges. and W. Witter, of Halle-on-Saale, Germany.

Treatment of Chromium Ores

CHROMIUM ores are treated with an alkaline hydroxide or carbonate in absence of free oxygen at a temperature above 100° C. to increase the percentage of chromium oxide. The ores may be fused with the alkali or treated with the alkaline solution under pressure. See Patent Application 288,973, bearing International Convention date April 16, 1927, by I.G. Farbenindustrie Akt.-Ges., of Frankfort-on-Main, Germany.

Current Articles Worth Noting

We give below a brief index to current articles in the technical Press dealing with metallurgical subjects.

ALLOYS.—The structure of silver-aluminium alloys rich in aluminium. M. Hansen. *Zeitschrift Metallkunde*, June, pp. 217–212 (in Germany).

Gold, silver, copper alloys. A record of tests made on two useful series of gold alloys. Part 3 (conclusion). F. E. Carter. *Brass World*, June, pp. 185–6.

Metals and alloys used for bearings. A. Seton. *Metal Industry* (London), July 13, pp. 29–30.

ANALYSIS.—Vanadium in chromium-vanadium-tungsten steels. H. H. Willard and P. Young. *Ind. Eng. Chem.*, July, pp. 764–768.

Persulphate method for chromium plus vanadium in chromium-vanadium-tungsten steels. H. H. Willard and P. Young. *Ind. Eng. Chem.*, July, pp. 769–770.

A new method for the colorimetric determination of small quantities of antimony and their separation from tin. S. G. Clarke. *Analyst*, July, pp. 373–379.

The estimation of impurities in spelter. The chemical analysis of commercial brands, electrolytic zinc, and dross. H. N. Merr. *Metal Industry* (London), July 20, pp. 53–54.

ANNEALING.—Annealing of metals in the electric furnace. R. M. Keeney. *Metal Industry* (New York), July, pp. 304–306.

BRASS.—Researches on copper and brass. O. Bauer, F. von Göler, and G. Sachs. *Zeitschrift Metallkunde*, June, pp. 202–208 (in German). Tenacity and distortion of variously treated sheet copper and brass. Dependence of crystal arrangement and cohesion on the properties of single crystals. Notch-cutting experiments with cold-pressed and re-annealed test bars. Dependence of tenacity on zinc content and heat treatment.

FLOTATION PROCESSES.—Flotation reagents. A. F. Taggart. *Mining and Metallurgy* (New York), June, pp. 257–262.

FURNACES AND FUELS.—The effect of coal segregation, mixing, and heating upon the quality of metallurgical coke. F. F. Marquard. *The Blast Furnace and Steel Plant* (Pittsburgh, U.S.A.), June, pp. 754–757.

Silica brick in the open-hearth furnace. B. M. Larsen. *The Blast Furnace and Steel Plant* (Pittsburgh, U.S.A.), June, pp. 803. Describes investigations of the changes that take place in silica brick, particularly in the open-hearth roof.

Refractories and the open hearth. J. R. Miller. *The Blast Furnace and Steel Plant* (Pittsburgh, U.S.A.), June, pp. 807–8.

Some common abuses of fire brick. L. S. Longenecker. *The Blast Furnace and Steel Plant* (Pittsburgh, U.S.A.), June, pp. 809–811.

GENERAL.—Researches on the reduction of oxide ores. M. B. Bogitch. *Revue de Metallurgie*, May, pp. 247–261 (in French).

HARDENING METALS.—The slip interference theory of hardening. M. G. Corson. *Mining and Metallurgy* (New York), July, pp. 304–307. Maximum hardness obtained with a fixed amount of precipitable matter depends on a proper balance of the number of particles and their size.

IRON AND STEEL.—Trend of engineering developments in steel. B. D. Saklatwalla. *J. Soc. Chem. Ind.*, July 13, pp. 198–212 T; July 27, pp. 210–212 T. Deals mainly with the production and properties of various types of alloy steels, and suggests appropriate directions of future research.

Medium-carbon pearlitic manganese steels. J. Strauss. *Trans. Amer. Soc. Steel Treating*, July, pp. 1–26.

X-rays and the constituents of stainless steel. E. C. Bain. *Trans. Amer. Soc. Steel Treating*, July, pp. 27–50.

The hardness and impact resistance of chromium-nickel steel. B. F. Shepherd. *Trans. Amer. Soc. Steel Treating*, July, pp. 67–71.

Inclusions in iron. A photomicrographic study. C. R. Wohrman. *Trans. Amer. Soc. Steel Treating*, July, pp. 81–126.

The manufacture of alloy steel. E. C. Smith. *The Blast Furnace and Steel Plant* (Pittsburgh, U.S.A.), June, pp. 762–765.

Basic open-hearth practice. G. B. Waterhouse. *The Blast Furnace and Steel Plant* (Pittsburgh, U.S.A.), June, pp. 766–769.

The internal structure of chromium steels. E. Maurer and H. Nienhaus. *Stahl and Eisen*, July 26, pp. 996–1005 (in German).

A contribution to the study of the cold drawing of mild steel. R. Giraud. *Revue de Metallurgie*, April, pp. 175–194; May, pp. 235–246 (in French).

SINGLE METALS.—A study of the principles governing the technical electrolysis of zinc, with special reference to current strength and composition of the electrolyte. P. Röntgen and H. Högel. *Metall und Erz*, June, Part 2, pp. 291–298; July, Part 1, pp. 319–327 (in German).

Investigations by means of X-rays on the structure of electrolytically-deposited copper. J. J. Trillat. *Revue de Metallurgie*, May, pp. 286–288 (in French).

Expansion of Canadian Zinc Plant

THE Consolidated Mining and Smelting Co. is engaged on the installation of a 100-ton addition to the electrolytic zinc plant at the Tadanac smelter at Trail, B.C., which will bring the total capacity of the plant up to 375 tons of zinc daily. The additional equipment will probably be in operation early next year, synchronising with the completion of the 60,000 horse-power hydro-electric power plant at Bonnington Falls. The completion of construction work now in hand will enable the company to embark upon the utilisation of accumulations of slag at the lead smelter, which will be made to yield up its zinc content, said to amount to as much as 20 per cent.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

London Gazette, &c.

Company Winding Up Voluntarily

THREE CASTLES LEAD CO., LTD. By special resolution, July 2nd, confirmed July 17. T. Ford, 37/41, Gracechurch Street, London, Chartered Accountant, appointed as liquidator.

Mortgages and Charges

*[NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.]*

ASKERN COAL AND IRON CO., LTD., London, E.C.—Registered July 9, mortgage, to Bradford Second Equitable Benefit Building Society, Bradford, securing balance of an account current not exceeding £14,500; charged on land and houses now in course of erection or intended to be erected thereon at Askern. *£643,069. July 14, 1927.

BEACH TIN DEPOSITS, LTD., London, E.C.—Registered July 2, £50,000 debentures; general charge.

EAGLE LEAD CO., LTD., London, E.C.—Registered July 4, £20,000 debenture, to S. Japhet and Co., Ltd., 60, London Wall, E.C.; general charge. *——. June 1, 1928.

PA VALLEY TIN FIELDS, LTD., London, E.C.—Registered June 23, £450 debentures, part of £3,000; general charge.

Satisfaction

BEARDMORE (WILLIAM) AND CO., LTD., London, S.W. steel manufacturers, etc.—Satisfaction registered July 2, £125,000 (not ex.) registered June 7, 1928.

Monthly Metallurgical Section

Published in the first issue of "The Chemical Age" each month.

NOTICE.—Communications relating to editorial matter for our Monthly Metallurgical Section should be addressed to the Editor, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4. Communications relating to advertisements and other business should be addressed to the Manager. Contributions will be welcomed from correspondents on any points of interest to metallurgists bearing on works practice or current research problems.

The Production and Uses of Tellurium

By G. Malcolm Dyson, Ph.D., A.I.C.

In the following article, Dr. Dyson, who has already dealt in this supplement with a number of metals and elements, deals with the comparatively little-known element tellurium.

IT would not be out of place to describe tellurium as the "bad boy of the elements," since much research has, so far, failed to find more than a very few uses for it or its compounds; and yet it is an element of great potentialities, which it seems that further research must ultimately lay bare for exploitation, whilst its potential production in the U.S.A. alone has been computed at 100,000 to 150,000 lb. per annum.

Occurrence

In 1782 there was discovered in the Mariahilf mine near Zalethna in the mountains of Fatzburg (Transylvania) a curious mineral of semi-metallic appearance. It was of a golden colour, and some gold was actually extracted from it, but Müller von Reichenstein, who examined the substance, named it "aurum paradoxum" or "metallum problematum," the former on account of the very small amount of gold which could be extracted from it, in spite of its golden colour, and the latter on account of its peculiar properties, which in many ways resembled those of a metal. He also gave it as his opinion that the mineral contained a hitherto unrecognised element. Later investigations have shown that the mineral was an impure specimen of native tellurium. Klaproth, in 1798, finally established the elemental nature of tellurium, to which he gave the latter name (from "tellus," the earth; in contradistinction to "selenos," the moon). It is to be noted that the more abundant element of the same family, selenium, was unknown at the time when tellurium was discovered.

Tellurium is not widely distributed naturally, although, in small quantities, it is nearly always associated with minerals bearing copper, gold and bismuth, and it is among these minerals that the commercial sources of tellurium are located. Among the more important tellurium minerals are the following:—

Sylvanite (Graphic Tellurium)	$(AuAg)Te_2$
Nagyagite (Leaf Tellurium)	$(AuPb)_2(TeSSb)_3$
Silver Telluride	Ag_2Te
Tetradymite (Bismuth Telluride)	Bi_2Te_3

Of these, only the third, silver telluride, is at all used for the production of commercial tellurium. It is found distributed among earthy matters in the various continental deposits, and this mixture ("Tellurreicherz") containing about 4–5 per cent. of silver telluride, is one of the two principal raw materials for the preparation of the element, although its principal value lies in its silver content. The other raw material is the anode mud obtained in the electrolytic refining of copper. This also contains gold and silver, traces of which have followed the copper through the various metallurgical operations.

Preparation of the Element

As might be anticipated, the method used for the extraction of tellurium depends not only upon which of the two raw materials is to be used, but also upon the fact that tellurium is regarded as a liability rather than an asset, and that it is the more valuable constituents of the mixture that are the main object of the operations.

In the first case, the "Tellurreicherz" is heated with concentrated sulphuric acid until no more sulphur dioxide is evolved. The solution is then decanted from insoluble matter, diluted with water, and the silver present precipitated by the addition of hydrochloric acid. Tellurium may be obtained from the filtrate by the passage of sulphur dioxide:—

$$H_2TeO_4 + 3SO_2 + 2H_2O = Te + 3H_2SO_4$$

It is evident from the whole of this series of reactions that the reaction between tellurium and sulphuric acid is reversible, and depends on the oxidising power of sulphur trioxide. In actual practice this is taken advantage of by using an oleum containing 20 per cent of SO_3 for the dissolution of the tellurium from the raw material. An alternative, but scarcely so satisfactory, method for dealing with the mineral (used when gold is present) is to heat the finely powdered raw material with aqua regia, evaporating almost to dryness and extracting the residue with water. Gold and telluric acid (together with some tellurium nitrate) dissolve, and from this solution gold is precipitated by means of ferrous sulphate and oxalic acid, whilst the tellurium is recovered as before by the use of sulphur dioxide. Any silver present remains as the chloride in the residue after extraction with water, and can be obtained by solution in hot ammonia.

The second source is by far the most important, and the bulk of the present demand for tellurium is supplied from the anode sludge of the copper refineries, notably the Raritan Copper Works and the U.S.S. Lead Refinery, Inc. Although anode sludge alone is worked for tellurim, the same methods can be adapted to the treatment of flue dust and to the slag and fume from cupellation. The method is a comparatively simple one, and resembles in certain essentials the production of selenium (see THE CHEMICAL AGE, Met. Supp., March, 1928, p. 17). The slimes are roasted in a strong current of air and the tellurium values converted to tellurium dioxide, which is deposited in the flues and cooling chambers in the form of minute white crystals, which in the case of copper slimes are almost invariably contaminated with arsenic and antimony oxides. The conversion of this crude oxide into tellurium metal is comparatively simple, since a low-temperature smelting with charcoal is all that is necessary.

Tellurium prepared by either of these methods is impure, and seldom contains more than 72 to 85 per cent. of the element. It can be purified in several ways: by fusion with potassium nitrate and conversion to potassium tellurate, which can be dissolved in water and the tellurium recovered by sulphur dioxide precipitation; by solution in nitric acid, followed by recrystallisation of the basic nitrate so formed, reconverting to the metal by smelting with charcoal; or by vacuum distillation, which is probably the best method, in spite of the fact that only about 60 per cent. of the tellurium distils over, the remainder being kept back in the residues. One method of purification, which is practised in America, depends on the observation made by Skowronski that tellurium can be deposited electrolytically from sulphuric acid solutions. By using suitable pressure and current density the tellurium can be refined in this way to 99.8 per cent. purity.

Properties and Uses

Tellurium is a brilliant white crystalline substance of strong metallic lustre, although the variety obtained by precipitation appears to be amorphous. It melts at 452° C. and boils at a considerably higher temperature. Many of its simple compounds have exceptionally repulsive odours, and after a small quantity of the powdered element has been eaten, the breath acquires a persistent alliaceous odour, which remains for several weeks. The estimation of tellurium in alloys is almost invariably done by the method of Lehner and Smith. A weighed sample of the turnings is placed in 150 cc. Pyrex flask furnished with a ground-in stopper and delivery tube, and a side arm in the manner of a distillation flask. The sample is washed down with 60 cc. of concentrated sulphuric

acid (*d* 1.84) and the acid heated to 300–330° C., while a current of pure hydrogen chloride is passed through the apparatus. The issuing vapours pass through a short water-cooled condenser into a quantity of water. After three hours the tellurium will have all been volatilised as tellurium tetrachloride,

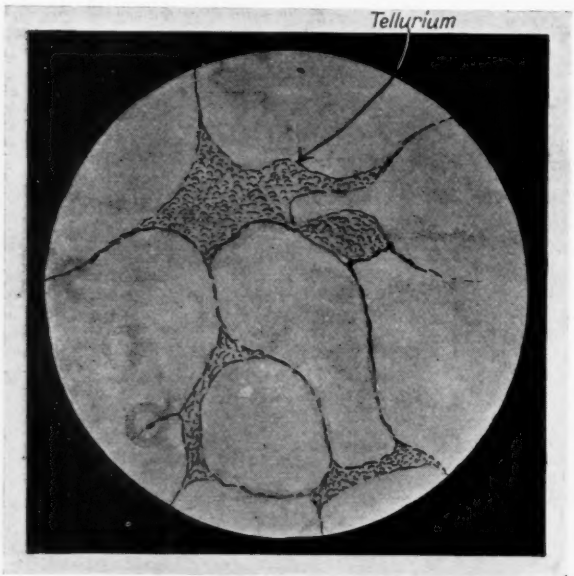


FIG. 1.—TELLURIUM SEGREGATING AT THE EDGES OF CRYSTALS WHEN ADDED TO ALUMINIUM BRONZE.

and will be contained in the distillate, from which it may be precipitated by hydrazine hydrochloride or sulphur dioxide, filtered, and weighed as metallic tellurium.

Tellurium has been used for a variety of purposes, but in comparatively small quantities. Thus, in the ceramic industry it is used for colouring glass and glazes blue or brown, while

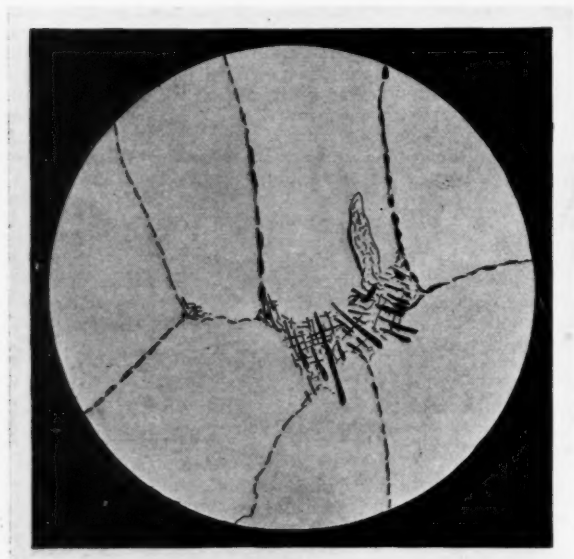


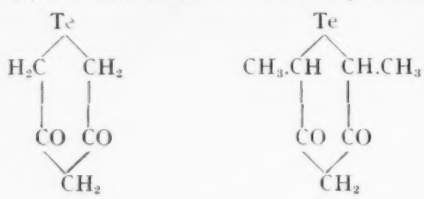
FIG. 2.—CONTROL BAR IN EXPERIMENT FROM WHICH FIG. 1 WAS OBTAINED.

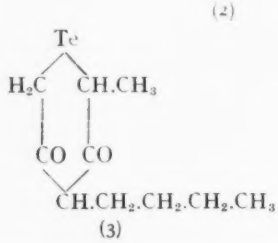
the sulphide can be used for producing a pink colour on porcelain. In photography, a solution of tellurium in sodium sulphide solution has been used as a colouring bath for prints. Diethyl telluride in a proportion of 0.2 per cent. may be used as an anti-knock in petrol. An investigation of the fungicidal properties of the tellurites was made by Stover and Hopkins, who found, however, that these were far less active in this respect than the selenites.

The principal immediate outlets for tellurium are in medicinal chemistry and in metallurgy, where it has been used in the preparation of certain alloys. In medicinal chemistry, it has been found that the compounds of tellurium have a certain bactericidal activity which may, in the future, make them of importance. Thus, various tellurium compounds, especially an iodine-quinine-tellurium compound of unknown constitution, have a rapid curative action on experimental syphilis, although it must be admitted that at present the efficacy of this compound is below that of the accepted arsenical compounds. The work of Morgan and his co-workers on the cyclic organic compounds of tellurium has shown that a strong bactericidal activity exists among them, and that the growth of organisms of the typhus group is inhibited at dilutions of 1 : 800,000. The most promising compounds that have been examined so far appear to be the cyclic tellurium diketones. The activity of these compounds against organisms such as the staphylococcus is particularly high *in vitro*, and becomes

FIG. 3.—EFFECT OF TELLURIUM ON STEEL.

a maximum when the parent compound, tellurocyclopentanedione (1) is converted into the 2 : 6 dimethyl derivative (2);





while if the "4" position is substituted by an alkyl group (3) the bactericidal activity appears to decrease as the number of carbon atoms in the group increases. The corresponding compounds containing selenium or cobalt in place of tellurium

were without any corresponding activity. The values for the principal substances are given in the table below :—

BACTERICIDAL POWER OF CYCLIC TELLURIUM COMPOUNDS.

Substance.	Limiting dilution showing bactericidal action, 1 part in :
Tellurocyclopentanedione	500,000
2-Methyltellurocyclopentanedione	3,000,000
2 : 6-Dimethyltellurocyclopentanedione	20,000,000
2-Methyl-4-ethyltellurocyclopentanedione ..	13,000,000
2-Methyl-4-propyltellurocyclopentanedione	8,000,000
2-Methyl-4-butyltellurocyclopentanedione ..	7,000,000

Alloys of Tellurium

A patent (B.P. 234,547) has been granted covering the use of tellurium as a scavenger during the casting of aluminium. Nosé and Chickashige examined the alloys of aluminium and tellurium, and demonstrated the existence of two definite compounds, Te_3Al and $TeAl_3$. Both are readily decomposed by water with the formation of tellurium hydride. The most comprehensive examination of alloys of this class was made by Sisco and Whitmore, who determined the effect of the addition of small quantities of tellurium to a 95 : 5 aluminium-copper alloy. The tellurium was added below the surface of the molten alloy, but subsequent analysis showed

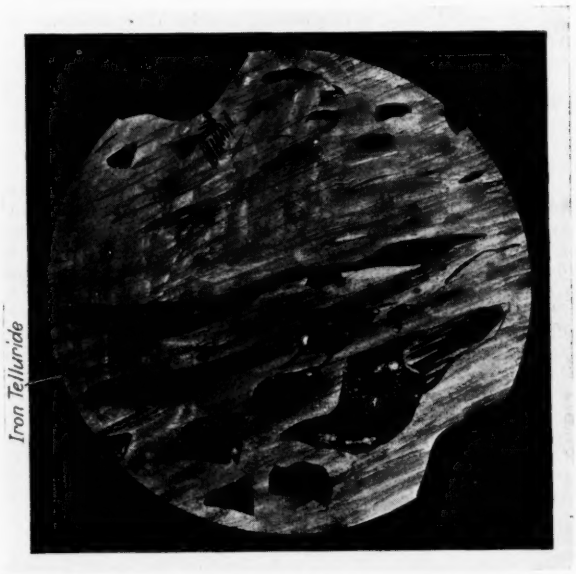


FIG. 4.—SECTION ALONG GRAIN OF FORGED TELLURIUM STEEL AFTER 65 PER CENT REDUCTION.

that only part of it (in reality, only a few per cent.) really alloyed with the aluminium bronze.

The figures in the table below show that the effect of tellurium on an aluminium bronze is almost negligible : micro-examination shows that the element tends to segregate at the edges of the crystals. This is very easily seen in Fig. 1, which is a diagram from a photo-micrograph of a section of bar 8 from the table below ; Fig. 2 is from the control bar. Both are magnified 500 times.

NUMBER.	TELLURIUM %	ULTIMATE STRENGTH. As Cast.	Quenched.*	Annealed.†
1	0.25	18,180	27,380	15,950
2	0.5	19,560	26,270	15,100
3	0.75	16,070	20,120	13,100
4	1	18,550	23,550	15,320
5	2	16,090	20,430	14,330
6	3	10,830	21,900	15,120
7	4	17,070	20,500	13,570
8	5	18,840	21,750	15,630
Control	Nil.	17,830	—	—

* Heated 96 hours to 510° C. and quenched in boiling water.
† Heated 96 hours to 510° C. and cooled slowly (12 hours to 48° C.).

Tellurium in Steel

The effect of tellurium on steel is a matter of no little interest, and has been examined in connection with one of the Americal steel plants (see *Iron Age*, December 13, 1923). The experiment was performed on a three-ton heat of low-carbon steel, and twenty pounds of tellurium was added during the casting as soon as the bottom of the ladle was well covered. About 40 per cent. of the tellurium was retained, and the final billet gave on analysis :

Carbon	0·24	Yield Point 45,000/42,850 lb. sq. in.
Manganese	0·64	Ultimate Stress 70,000/71,750
Phosphorus	0·039	Elongation in 2 in. 11·5/16·0
Sulphur	0·039	Reduction in Area 13·5/18·5
Silicon	0·32	
Tellurium	0·12	

The mechanical properties of two samples cut from opposite ends of the billet are also given above. It appears that the ductility has been slightly lowered. In the micro-examination the tellurium was located with the constituent known as "manganese sulphide," and can be seen in Fig. 3, as a dark patch on the dove grey manganese sulphide. The investigators provisionally termed the new constituent iron telluride, although there is no real evidence that it is of this constitution. The presence of the tellurium has little effect on the forging or rolling qualities of the steel, in which no trace of red-shortness was observed. Fig. 4 shows the photo-micrograph of a section along the grain of a piece of forged tellurium steel after 65 per cent. reduction. The iron telluride appears to have elongated equally well with the manganese sulphide, and it seems that some inquiry should be made into the machining qualities of tellurium steel.

Some Useful Publications

SEVERAL pamphlets and monographs of interest to metallurgists are published by Adam Hilger, Ltd., of 24, Rochester Place, Camden Road, London. "Recent Applications of the Spectrograph to Metallurgical Analysis" gives an account of the method and of the necessary equipment. This may be obtained free, and is also available in German. "Quantitative Spectrum Analysis," by F. Twyman, F.R.S., and D. M. Smith, is a reprint of a paper read by the authors before the American Institute of Mining and Metallurgical Engineers, and may be obtained from Adam Hilger, Ltd., at a cost of 1s. 6d., post free ; this charge also applies to "Some Useful Applications of the Quartz Spectrograph," by F. A. Hull and G. J. Steele, a paper read before the American Society for Testing Material. In the latter paper there is an interesting account of a copper anode in an X-ray tube which gave trouble, and which showed no impurity when analysed by ordinary methods. On examination in a Hilger spectrograph, however, traces of zinc were immediately detected in the copper, and it was possible to obviate the difficulty at once. This is but one instance of the way in which the new methods of analysis and investigation can be of real assistance in everyday practice. Metallurgists who wish to remain abreast of the times would be well advised to acquire some knowledge of the new methods.

Canada Fourth in Copper Production

STATISTICS on world production and consumption of copper recently prepared by the American Bureau of Metal Statistics show that Canada last year reached the fourth place among the producing countries. Figures for mine production do not quite agree with the Canadian official statistics, but are nevertheless interesting so far as they compare the growth of Canadian production with that of other countries. Canada is credited by the American Bureau with a mine production of 70,098 short tons of copper in 1927, an increase of over 10 per cent. The United States, which is still by far the greatest producer, is stated to have had a production last year of 847,419 tons as compared with 878,000 tons in 1926, a decrease of 3·6 per cent. Chile is credited with 264,242 tons, compared with 223,015 tons, an increase of 18·5 per cent., and Africa with 120,763 tons, compared with 108,010 tons, an increase of 11·8 per cent. For Japan, which held fourth place in 1926, a slight decrease is shown from 72,277 tons to 68,872 tons last year. Canada's copper production, while relatively small in relation to a total world production estimated at 1,674,808 tons, is destined to grow rapidly. The Noranda smelter at Rouyn, Quebec, operating on ores from the Horne Mine, poured copper for the first time in December, 1927. Other mines will also begin to produce copper shortly.

Metallurgical Topics: Monthly Notes and Comments

From Our Own Correspondents

Blast Furnace Practice

An event of no little importance is looming in the metallurgical world. Ernest Benn, Ltd., have in the Press a work on blast furnace practice of a scope and extent never hitherto even contemplated. Iron and steel men are all familiar with the truly admirable papers written by Mr. Fred Clements on British Blast Furnace Practice; British Siemens Furnace Practice; and British Steelworks Gas Producer Practice, respectively. These were presented at meetings of the Iron and Steel Institute in 1920, 1922 and 1923. The "schedules" with which these papers were accompanied have become classical, embodying, as they did, the most minute working details of their respective subjects, culled from a wide range of practice. The book which is now in active preparation deals with blast furnace practice only, and not, as in the case of Mr. Clements' paper on the subject, from the British point of view alone, but from that of world practice generally.

We have been privileged with a view of the work in hand, which will consist of three volumes, dealing with every conceivable aspect of the subject of blast furnace practice. It is profusely illustrated, and the famous "schedules" have been recast and amplified, and include a vast amount of new information. It is no exaggeration to say that no technical work of this bulk, importance and scope has ever before been published in connection with any industry, and the amount of labour it must have involved is incalculable. It is a matter for congratulation that this encyclopædic work should have been conceived and carried out in this country, and that it should thus serve to show that, in the metallurgy of iron and steel, this country still leads the way. Mr. Clements' great book, when it appears, will enhance enormously his already acknowledged authority. The publishers have displayed great enterprise in undertaking the publication of this remarkable work.

Wrought Iron

In respect of the "iron" shackle which broke on the occasion of the crane disaster in Tavistock Square recently, it would be interesting to know rather more than transpired at the inquest. Failures in wrought iron—assuming wrought iron was employed—used to be very rare, and are still, happily, not common. There is no doubt that really good wrought iron ranks high in regard to reliability. The pity of it is that a good deal of the wrought iron about is by no means what it ought to be. In the meantime, the wrought iron trade is perhaps the most depressed of all the depressed iron and steel trades, and seems to be beset by a strange apathy which makes it more unmindful of its real interests and less jealous of its former excellent reputation than it ought to be, seeing the rivalry it has to contend with in the mass production of commercially pure iron. In these circumstances, the support which is being given to the revival of a local wrought-iron working industry by the Nottinghamshire County Council, in conjunction with the Rural Industries Board, should help the wrought iron makers.

The scheme involves the encouragement of blacksmiths in the district to fill up their spare time by making ornamental iron work. It is by no means confined to small articles such as tongs, shovels and pokers, but includes such things as wrought iron gates. A pair of such gates, made for an American customer, gave such satisfaction that the customer sent, in payment thereof, a cheque for £300, a sum well in excess of the amount originally charged for the work. Anything tending to a real revival in interest in and demand for wrought-iron work is a matter that should be sedulously fostered.

Some Mysteries Concerning Iron

We know a great deal about the influence of impurities present, so to speak, in bulk, although not all we ought to know respecting the presence of gases in metals. What we know a good deal less about is the influence of minute traces of any one material on a metal otherwise pure. It is this that lends so great an interest to the production of such "pure" metals; they form the basis for experiments on the effect of almost infinitesimal amounts of "foreign" substances. It is probably in this direction that some of the outstanding mysteries connected with wrought iron are still enshrouded. Is the "body" or "life" of a steel tool, or razor, connected, for instance, with the presence of such impurities or the relative absence of them? It seems probable that the total absence of, say, phosphorus, or even slag, gives a very lifeless material from which only a third-rate steel can be produced. What, for instance, is the real cause of the undoubted excellence of Swedish charcoal iron? Is it the low percentage of sulphur and phosphorus, reduced to limits which are of a "critical" nature, so far as quality is concerned, and below which a given quality, valuable in itself, tends to deteriorate or even to disappear? A revival of interest in wrought iron, or an extension of the uses of such material as "Armco" ingot iron, would serve to clear up some of these puzzles, if, at the same time, careful investigations of a comparative nature were made.

The "New" International Testing Association

The methods and instruments used in testing materials are of paramount importance, and this is more especially the case with metals used in engineering and building construction, in which a margin of safety is obviously necessary. This can, however, only be provided if and when the methods of testing be rigorously investigated, and rendered strictly comparable. At present, many tests are empirical, which may or may not suffice for industrial needs, but will not satisfy those of science. The International Association for the Testing of Materials responded to those needs, and did a good deal of useful work. Unfortunately, it construed its "mandate" rather too broadly, and went in, not only for international standards of testing, but for international specifications as well. A national association may well carry out the dual task, and indeed the admirable American Association for Testing Materials deals with both, and deals with them very successfully. It has, however, never sought to create international specifications, and it was due to insistence in endeavouring to do this that the International Association of pre-war days showed signs of breaking up, and in any case incurred the suspicion and hostility of important interests. When, therefore, suggestions were made three or four years ago for its revival, this country held aloof; and, as recently as this time last year, on the eve of the Amsterdam Congress, British opinion was not in favour of its resuscitation.

British Representation

It is interesting, therefore, to note that opinion has changed. In the body which (in contradistinction to the original International Association for the Testing of Materials) is to be called the "New International Association for the Testing of Materials," the question of specifications is to be taboo. Moreover, British participation in the Association, now confined to the objects expressed in its title, is to be official, and a powerful British Committee has been formed, which Sir Henry Fowler as chairman, and with representation from practically every British Society and Institution concerned.

The New Association has four sections devoted respectively to (A) Metals; (B) Inorganic non-metallic materials: cement, concrete, etc.; (C) Organic materials: oil, indiarubber, etc.; and (D) Methods of testing. Dr. W. Rosenhain, who is a vice-president of the Association, is chairman of the Metals Section. He is, moreover, the delegate of the British Committee on what is called the permanent committee of the New Association. Each of the sections has an International Committee of its own, but there appears to be no British representation on the other three. The constitution, as before, seems somewhat complicated, but in any case, as far as British interests are concerned, metallurgists at least may feel assured that they are in good and strong hands. The general membership of the Association, in the case of British members, is secured by joining the main body, the fee being 10s. annually for individuals and 20s. (or any higher sum) for Corporate membership. There are certain privileges attaching to membership, and a Bulletin is to be published, which seem to be quite adequate value for the small fees levied. As the whole

movement is of interest and utility it is hoped that due support, in the form of such membership, will be forthcoming in this country.

Beryllium Alloys

ALTHOUGH, up to the present, beryllium has fallen short of the high hopes held out as to the wonderful results that were to accrue from its use, work on the metal is still progressing quietly in many countries, and, while nothing spectacular has as yet emerged, some further information as to its alloys is forthcoming. Thus Masing and Dahl, in Germany, have been experimenting with beryllium-copper and beryllium-nickel alloys, which display high tensile and transverse strength, and considerable hardness, although their elongation is inconsiderable. This is interesting and curious, seeing that the beryllium-copper alloys are described as being capable of being rolled, pressed and extruded.

Another remarkable result of the addition of beryllium to nickel, cobalt, and iron is the high Brinell hardness developed on annealing. This is greater by anything from 200 to 500 per cent. Thus, an alloy with 2 per cent. of beryllium and 98 per cent. of nickel which, when quenched, had a hardness of 78, could, by annealing, be given a hardness of 279·5. A beryllium-iron alloy containing 4 per cent. of beryllium and 96 per cent. of iron displayed, on annealing, a Brinell hardness of no less than 409, whereas in the quenched condition the hardness was no more than 168. The quenching, in both instances, was carried out at 1,150° C., while annealing was effected at between 400° and 700° C. In the case of a beryllium-cobalt alloy (4 per cent. Be ; 96 per cent. Co.) the hardness in these circumstances, rose from 177 to 418. It is plain, from the foregoing, that there may be many very valuable applications found for the beryllium alloys, despite the fact that they will inevitably be expensive. In aluminium and magnesium alloys, however, the beryllium acts like silicon, and although it does so to a rather more marked extent, the advantages attending its use are not commensurate with the greatly increased cost.

South African Developments

THE chairman of the South African Iron and Steel Corporation, Dr. H. J. Van der Byl, and another Government director, Mr. Delfos, are proceeding to Europe at an early date with the object of obtaining the necessary plant to start the industry in Pretoria. The post of technical head of the organisation, carrying a salary of £5,000 per annum, is being offered to Dr. Lilge, of the Gutehoffnungshütte Company, who led the delegation of German experts on whose report the Government scheme has been based. Dr. Meyer, technical adviser to the Board of Trade, has been appointed technical secretary to the Corporation. No decision has yet been reached in regard to the site of the works, but this may be at Daspoort, a few miles outside the town, rather than at Pretoria West. It is stated that negotiations are proceeding with the Union Steel Corporation, with a view to securing co-operation, and there is a prospect of an agreement being reached.

Power for Aluminium Production

THE Council of the Mining Institute of Scotland have arranged an excursion for members to visit and inspect the work in progress on the Lochaber Scheme, near Fort William. The Scheme, described shortly, is that factories for the manufacture of aluminium are to be erected by the British Aluminium Co. on the low-lying ground at Inverlochy, near Fort William, and that large volumes of water at high pressure are to be used to generate electricity for electric furnaces and for power generally. To get the necessary quantity of water, Loch Treig, 14½ miles east, as the crow flies, from Fort William, and 784 ft. above sea level—with the Lochaber range of hills and Ben Nevis lying between—is to be tapped at about 100 ft. below its present surface level by a tunnel 15–16 ft. diameter. This tunnel, which is to be almost 15 miles long, is now being driven through the Lochaber Hills, and is being cut from twelve points either by shafts or adits. Provision is being made to collect every useful stream from the mountains, and direct them into the finished tunnel, along the whole 15 miles length.

From the end of the tunnel at Inverlochy, pipe lines will lead the water down the hill side to the factories, where, after serving the turbines, the water will discharge into Loch Linnhe, an arm of the sea. To enable the tunnel driving to be done, a light railway, 23 miles long, was laid along the tunnel route from Inverlochy to Fersit on Loch Treig, and camps were established at all the shafts and adits. A temporary power station, with turbines driven by water from the river, was also erected at Monessie on the Spean, and this serves the works with 4,500 h.p., at 11,000 volts, *via* some 30 miles of transmission line. The British Aluminium Co., Ltd., for whom the work is being done, and Balfour, Beatty and Co., Ltd., the contractors, have very kindly given permission for members of the Mining Institute to visit and inspect the various works. The visit will take place on September 20, 21 and 22.

An American Lead Institute

PROMINENT figures in the United States lead industry are taking steps towards the formation of a Lead Institute, similar to the U.S. Copper Institute. A programme of work was drawn up in the middle of July. Mr. Cornish, president of the National Lead Co., states that his company would join the organisation. Production statistics of lead are, he says, now obtainable quickly, and with regularity, but those for consumption are less satisfactory. The main function of the new Institute would be the provision of these statistics. The American Smelting and Refining Co. and the Westinghouse Electric Co. are also favourably disposed towards the formation of the Institute.

The Institute of Metals' Autumn Meeting

NEXT week (September 4 to 7) the autumn meeting of the Institute takes place at Liverpool. As already announced in these columns, Mr. F. G. Martin will deliver the Autumn Lecture, entitled "Non-Ferrous Metals in the Shipping Industry." A large number of communications are expected to be submitted, of which one of the most interesting will be the Eighth Report of the Corrosion Research Committee. The report will be delivered by Mr. R. May, A.R.S.M. (investigator to the Committee) and will deal with "The Corrosion of Condenser Tubes. Impingement Attack: Its Cause and Some Methods of Prevention." Visits will be made to a number of works. The social side of the meeting is being carefully organised, and among other things there will be a trip into Wales, visiting Bettws-y-Coed and Dolgarrog.

Oxidised Lead Ore Containing Molybdenum

SEVERAL mines in the Star district near Milford, Utah, have recently struck bodies of oxidised lead ore containing large quantities of plumbojarosite and some wulfenite. The lead molybdate appears to be uniformly distributed through the ore now being mined and analyses show a molybdenum content of 4 per cent. The iron content of samples brought to the Bureau of Mines was 30 per cent., and they contained about 20 per cent. of lead and 9 ounces of silver. Under present conditions this ore is shipped to the smelter and is paid for on the basis of its lead and precious metal content. The molybdenum is slagged off with the iron, and therefore constitutes not only a total loss but also an economic waste. Ores of a similar type occur in other mines of the Star district and also in other localities, and in some instances they are of too low a grade to be mined and shipped at a profit. Ores of this general type are difficult to treat because of their plumbojarosite content, and are not amenable to gravity or flotation concentration. Such ores usually occur in regions where the water supply is deficient, which further complicates matters.

An experiment conducted on ore from a certain mine indicates that a high recovery of the lead, and probably the silver, can be obtained by chloride volatilisation, which appears peculiarly adapted to this type of ore. The results of treating a sample of this ore for one and a half hours by this method, using 10 per cent. of NaCl and a temperature of 850 degrees C., showed removal of 94 per cent. of the lead. The calcine showed no tendency toward sintering, and it was thought that its further treatment under conditions similar to those used in producing sponge iron might result in metallisation of the iron and molybdenum, thus producing ferro-molybdenum. The calcine was mixed with equal parts of minus 8 mesh coke, and treated for one hour at 1,000° C. The metallised content from this treatment was removed with a magnet, and analysis showed that it contained 88 per cent. of iron and 11·6 per cent. of molybdenum.

Trade, Commerce, Finance: The Month in Review

From Our Market Correspondent

THERE has been no relief in August in the iron and steel trade from the dulness which characterised the previous month; indeed, this dulness has become more pronounced under the influence of the holiday season. Orders generally have fallen off, and to make matters worse there is a noticeable lack of enquiry for new business. One is accustomed to this condition at the present season of the year, although that is small comfort to the steel makers who have the choice of either running the mills on part time or closing them down for a short period until sufficient orders accumulate to warrant a start being made. Moreover, there is little confidence in the prospects for the near future.

Prospects for September

Apart from the seasonal revival which generally follows the holiday period, and which will no doubt again occur, one can see no reason for expecting a substantial improvement in the state of trade. September should certainly show an upward movement, but it is hardly likely to be more than will bring us back to a position similar to that which obtained at the end of the first half of the year. It is in vain one looks for some event to set in motion those business forces which will carry the trade on to a renewal of that prosperity which was the happier experience of past years. It is good to preserve a spirit of optimism as long as possible, even in spite of adverse circumstances, but it requires a great effort and some imagination to be optimistic about the iron and steel trade at a time like the present, when shortage of work and financial distress seem to be the general experience throughout the trade.

There is no relaxation of effort on the part of the leaders of the industry to carry on until better times appear, but when one listens to the exchange of views at their monthly gatherings, one is impressed with the seeming hopelessness of the struggle. The financial reorganisations which are necessitated by this unhealthy condition are carried through, the shareholders being compelled to agree to them by the threat of the only alternative, liquidation.

Steel Works to be Restarted

The Redbourne Hill Iron and Steel Works in Lincolnshire are to be restarted. They have been closed for about four years, and it is now stated that definite instructions have been given for one of the blast furnaces to be lighted up at once, and for the restarting of the steel works in December. On the other hand, it may be pointed out that in the Sheffield area alone, where there are 90 open hearth furnaces, only 36 are at present in operation. These figures show the relation between productive capacity and the demand for steel.

On the Continent, there seems to be some improvement. The reports are that makers there have good order books and prices are firm, with a tendency to advance. Orders from this country for Continental steel have been rather less recently, but this has not called forth any response from the Continental makers, who state that they are sufficiently well booked to maintain their prices for some time to come. There is less competition from abroad in the cheaper classes of steel, as the home prices are low enough to keep a good portion of the business in this country.

The Continental makers are continuing their efforts to secure a larger share of the trade in the better qualities and special steels, and if they succeed in any great measure, their competition will be more formidable than ever. At the present level of prices, it is only the special steels and the better qualities which offer any margin of profit, and it is these alone which have enabled some of the steel works to preserve their existence.

Pig Iron Position

Reports from the various pig iron centres show that there is very little buying taking place just now. Current requirements are on the small side and forward business is scarce. The trade is simply not there at present, and all that makers can do is to wait as patiently as possible for the renewal of demand which they are hoping will come in the autumn. Prices are comparatively firm, indeed they have reached such a low level that further reductions are practically impossible.

In the Cleveland district one of the chief items of interest is the closing down of the two blast furnaces of Palmers at Jarrow. These were the only pig iron makers remaining outside the Cleveland Ironmasters' Association. This will strengthen the hands of the Cleveland makers and confirm them in their decision not to make any further concessions in prices. In the Midlands, there seems to be an abatement of the intense competition which was in force amongst certain of the makers, and prices have not changed. In the absence of any business of magnitude, makers are finding it better policy to maintain prices in the expectation of the improved demand which the next month should bring. There will be no hurry to increase output, as the stocks at the furnaces will take care of the demand for some little time. The hematite market is in a similar position as regards business and prices. The orders available do not warrant any addition to the number of furnaces in operation, but stocks are low and there is, therefore, no disposition to reduce further the already low prices.

Finished Steel Trade

In the finished steel trade the position remains very much as it was a month ago. Business is very patchy, and orders are so intermittent that there is no certainty of regular working. Prices show no improvement, although they are no worse. The official Association prices remain unchanged, and the bottom appears to have been reached in the low prices quoted for uncontrolled materials. Although at the moment there is no opportunity of advancing these uncontrolled prices, it is possible that when the autumn revival does set in there will be a slight upward movement, which will surely be welcome to the makers.

The steel plate trade is as unsatisfactory as ever. Orders are nothing like sufficient to keep the mills in full operation, and one can see no prospect of an improvement. In no other section of the trade is there so much over-production as in plates. Apart from the possibility of a largely increased demand for shipbuilding—of which there is no likelihood at the moment—there is no prospect of orders to keep all the mills busy.

Demand for Boiler Plates

There is a fairly good demand for boiler plates, due to the activity of the locomotive builders in Lancashire, although prices have reached such a level that there is only a slight margin of profit to the plate makers. In steel sections trade is quiet, and such orders as are available are sent to the works which can give the best delivery. There is just now an increased demand for steel arches for the collieries.

The production of pig iron in July amounted to 537,800 tons, compared with 563,700 tons in June. The number of furnaces in blast at the end of the month was 10 less than at the beginning. The production of steel amounted to 666,900 tons, compared with 709,500 tons in June.

American Concessionaires and Russian Manganese

IT is understood that the conflict which arose at the beginning of this year between the Georgian Manganese Co., the American concessionaires of the manganese fields in the Caucasus, and the Government of the U.S.S.R. (Russia), and led to the concessionaires' appeal for arbitration, has been settled by an agreement that makes the arbitration unnecessary. The main result of this agreement, reached after long negotiations between Mr. Piatakoff and Mr. Robinson, the authorised representatives of the Soviet Government and the Georgian Manganese Co. respectively, is the Government's consent to the discontinuance of the concession in Tchiatouri, and to repay, within a certain period of time, the capital invested by the Georgian Manganese Co. in the enterprise, amounting to several million dollars, and permit the concessionaires to revert to former property owners the property turned over by them to the concessionaire. At the same time the Soviet Government is to be granted, by an interested American company, a loan for the further development of the manganese industry in Tchiatouri. The agreement was ratified by the Government in Moscow on August 21, and its final execution is expected at the end of this month.

Some Inventions of the Month

By Our Patents Correspondent

***Abstracts of other Patents of metallurgical interest will be found in our Patent Literature published weekly in* THE CHEMICAL AGE**

Alloys

ALLOYS containing lead, especially the bronzes containing 2–10 per cent. of tin and 10–28 per cent. of lead, are melted with about 2 per cent. of calcium carbide to disperse the lead uniformly and to render the alloy suitable for bearings. See Patent Application 291,462, bearing the International Convention date June 4, 1927, by Metropolitan-Vickers Electrical Co., Ltd., of Westminster, Assignees of W. J. Merten, of Pittsburg, U.S.A.

THE manufacture of alloys containing nickel and chromium, with, in some cases, a small addition of molybdenum or tungsten or both, is described in Specification 293,727, dated April 7, 1927, by the General Electric Co., Ltd., of London, and C. J. Smithells, of Wembley, Middlesex. The pure, powdered metals are heated together in an atmosphere which prevents the introduction of harmful impurities, preferably in a gas such as pure hydrogen, capable of assisting in the removal of oxides present in the metals. The preparation of powdered metals of sufficient purity by electrolytic deposition is described in the Specification, and a specially pure hydrogen may be obtained by the process described in Specification 284,808 (see THE CHEMICAL AGE, Vol. XVIII, p. 224). The products, owing to their mechanical stability, and resistance to chemical action, are suitable for making the resistance elements of electric heaters.

Extracting Metals

A PROCESS for extracting metals from certain of their compounds by physical dissociation is described in Specification 294,795, dated September 22, 1927, by Vacuumschmelze G.m.b.H., of Frankfort-on-Main, H. Gruber and W. Rohn, of Hanau-on-Main, and O. H. Weber, of Griesheim-on-Main, Germany. The solid or fused compounds, particularly oxides and sulphides, capable of being dissociated at an elevated temperature, are subjected to a vacuum exceeding the dissociation tension corresponding to the temperature of the compounds to be dissociated, until the dissociation has been completed. The extraction of iron, copper, nickel, tungsten, and molybdenum is referred to. The process is also applicable to the production of alloys from mixtures of compounds.

Hardening Metals

METALS are case-hardened by immersion in a molten bath of fused salts with addition at frequent intervals of small amounts of a compound containing the -CN radical, such as sodium cyanide, calcium cyanamide, or a compound formed by fusing calcium cyanamide with sodium chloride. See Patent Application 292,557, bearing the International Convention date June 22, 1927, by P. W. and E. B. Shimer, of Easton, Pennsylvania, U.S.A.

IN hardening metal articles by nitrogenation, the parts of the articles not to be treated are provided with a metallic coating, e.g., of tin or a tin alloy. These parts may also be coated with water glass and powdered aluminium. Before nitrogenation, the whole article or the tinned parts may be dipped in a bath of potassium or sodium nitrate heated to about 400° C. See Patent Application 290,214, bearing the International Convention date May 10, 1927, by P. F. M. Aubert and A. J. P. and H. A. M. Duval (trading as Aubert et Duval Freres), of Paris, Assignees of F. Krupp Akt.-Ges. of Essen, Germany.

A PATENT of addition has been applied for in connection with a modification of the process for hardening iron or steel described in Specification 277,030 (see THE CHEMICAL AGE, Vol. XVII, p. 47 [Metallurgical Section]). The process is carried out at 900° C. and over, local overheating of the bath being avoided by adjustments directed to avoiding the use of pointed flames, and the froth-preventing agent being dispensed with. A protective layer is formed on the surface of the bath by addition of substances such as graphite, which react with the atmospheric oxygen. See Patent Application 291,423, bearing the International Convention date June 4, 1927, by Deutsche Gold und Silber-Scheideanstalt vorm. Roessler, of Frankfort-on-Main, Germany.

Tin

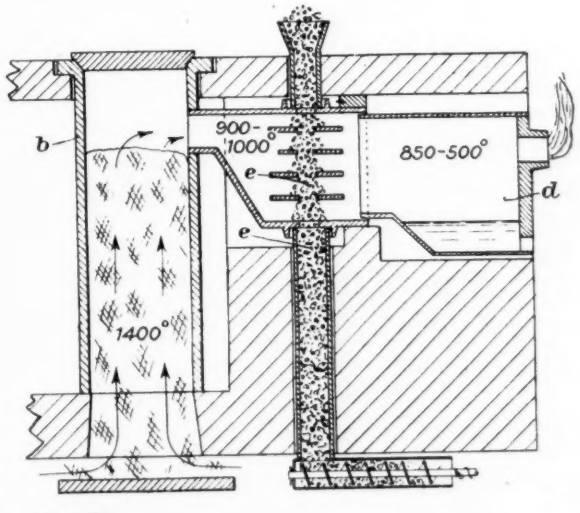
A TIN-EXTRACTING process of the type comprising the heating of the tin-bearing material in an atmosphere containing sulphur or a sulphur compound and treating the sulphidised product to separate the tin is described in Specification 294,703, dated February 6, 1928, by F. L. Wilder, E. Morris, E. Schiff, and E. S. King, of London. The heating is effected under such conditions that only a small proportion of the sulphidised tin is volatilised, and the solid residue containing the bulk of the tin sulphur compounds is passed into an alkali polysulphide solution, from which the dissolved tin is recovered, as by electrolysis. For this purpose, the temperature of the reaction zone is maintained at 200-300° C., and the concentrated sulphuretted vapours are circulated through this zone at a comparatively slow rate. Any volatilised tin sulphide carried off by the circulated vapours is condensed, preferably in ammonium carbonate solution, the condensed product freed from carbonate and dissolved in alkali polysulphide solution. Apparatus for carrying out the process is described and illustrated.

Wet Extraction Processes

A PROCESS for the recovery of tin and other metals from pyritic ores or residues is described in Specification 291,919, dated April 6, 1927, by F. L. Wilder, E. Morris, E. Schiff, and E. S. King, of London. The ores, etc., after oxidation, are treated in finely divided form with ammonia solution, preferably under pressure and in presence of ammonium carbonate, after which the liquors are removed and the residues are subjected, also, if desired, under pressure, to the leaching action of a hot acid brine. The ammoniacal treatment and leaching are preferably effected in a rotary autoclave without removal of the solids from the autoclave. The ammoniacal extract contains the tungsten, copper, etc., the brine extract contains the silver, lead, zinc, etc., and the tin is recovered from the residue. In some cases it is advantageous to leach with an alkaline brine before leaching with the acid brine.

Zinc

IN a process for extracting compact zinc in vertical muffles or shaft furnace-like devices, with external heating and simultaneous internal heating by combustion of a portion of the reduction carbon contained in the charge, the zinc oxide formed by the internal combustion is separated from the useful zinc vapours before the latter are condensed into molten



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zinc in the zinc plant. In the arrangement shown the vapours leaving the muffle *b* traverse a stream of granular coke or like material *e* moving vertically downwards, the zinc oxide being condensed at 900–1,000° C. on this material, while the zinc is condensed at 850–500° C. at *d*. See Specification 294,127, dated April 6, 1927, by A. Roitzheim and W. Remy, of Berlin.

Current Articles Worth Noting

We give below a brief index to current articles in the technical Press dealing with metallurgical subjects.

ALLOYS.—Antimony-tin alloys. W. Broniewski and L. Sliwowski. *Revue de Métallurgie*, June, pp. 312–321 (in French).

A contribution to the study of the solution of aluminium and its alloys in acids. M. X. Waché. *Revue de Métallurgie*, June, pp. 331–346 (in French).

The effect of added chromium on the electrical properties of iron-nickel alloys. P. Chevenard. *Stahl und Eisen*, August 2, pp. 1045–1049 (in German).

Investigations on the acid-resisting qualities of very pure chromium-nickel-iron alloys. W. Guertler and W. Ackermann. *Zeitschrift für Metallkunde*, August, pp. 269–279 (in German).

Silicon-aluminium cast alloys. J. Dornauf. *Zeitschrift für Metallkunde*, August, pp. 289–292 (in German).

X-ray analysis of silver-aluminium alloys. A. F. Westgren and A. J. Bradley. *Philosophical Magazine*, August, pp. 280–288.

A study of tin base bearing metals. O. W. Ellis and G. B. Karelitz. *Metal Industry* (London), August 10, pp. 132–134, and August 17, pp. 156–158.

ANALYSIS.—The determination of vanadium in steel. A. T. Etheridge. *Analyst*, August, pp. 423–428.

Current analytical practice in metallurgical works. L. Persoz. *Revue de Chemie Industrielle*, June, pp. 190–193 (in French).

New methods for the quantitative spectrometric analysis of metals. W. Gerlach. *Zeitschrift für Metallkunde*, July, pp. 248–251 (in German).

The quantitative determination of undesirable sulphur in roasted blendes. E. Beyne. *Annales de Chimie Analytique*, August 15, pp. 221–225 (in French).

COPPER.—The prospects of the Amenabar process for the extraction of copper by means of iodine, employing wet methods. E. Hentze. *Metall und Erz*, August, Part I, pp. 370–372 (in German).

ELECTROLYTIC PROCESSES.—The influence of the cathode in the electro-deposition of chromium. H. S. Lukens. *Metal Industry* (New York), August, pp. 354–355.

FURNACES.—Refractory materials for electrical metallurgical furnaces. A. B. Searle. *Iron and Steel Industry*, July, pp. 313–316; August, pp. 343–345.

Studying blast furnace gas. W. G. Imhoff. *Iron Age* (New York), August, pp. 393–394. Watching formation of graphite. Some of the conditions which produce rapid driving and high iron output.

Methods of cleaning blast furnace gas. V. Harbord. *Blast Furnace and Steel Plant* (Pittsburgh, U.S.A.), Part I, July, pp. 901–905; Part II, August, pp. 1030–1033.

GENERAL.—A new procedure and some new principles in the metallurgy and dressing treatment of complex sulphide ores. H. Skappel. *Metall und Erz*, August, Part I, pp. 367–370; and August, Part II, pp. 400–411 (in German).

IRON AND STEEL.—A contribution to the study of the cold drawing of mild steel. Part III. The amount of energy absorbed by the metal as potential energy. R. Giraud. *Revue de Métallurgie*, June, pp. 347–354 (in French).

Molybdenum steels. F. W. Rowe. *Iron and Steel Industry*, August, pp. 339–341.

Metallurgical theories for the practical iron and steel man. C. H. Plant. *Iron and Steel Industry*, August, pp. 350–352.

The tempering process in hard steel and the influence thereon of silicon and nickel. H. Birnbaum. *Stahl und Eisen*, August 16, pp. 1125–1126 (in German).

The inner structure of chromium steels. I. The carbides contained in chromium steels. II. Changes occurring in the solid state. E. Maurer and H. Nienhaus. *Stahl und Eisen*, July 30, pp. 996–1005 (in German).

The heat treatment of ferrous metals. C. M. Walter. *J. Soc. Chem. Ind.*, August 3, pp. 791–797T.

British and American automotive steels. J. W. Urquhart. *Blast Furnace and Steel Plant* (Pittsburgh, U.S.A.), Part I, July, pp. 906–908; Part II, August, pp. 1027–1029. Discusses the differences between British and American (especially Ford) practice, with particular reference to heat treatment methods and the use of alloy steels.

Effect of heat treatment on the properties of chromium-molybdenum sheet steel. F. T. Sisco and D. M. Warner. *Trans. Amer. Soc. Steel Treating*, August, pp. 117–192.

An assumption as to the cause of allotropic changes of iron. D. Jones. *Trans. Amer. Soc. Steel Treating*, August, pp. 199–210.

Some effects of heat on the physical properties of steel. J. L. Cox. *Trans. Amer. Soc. Steel Treating*, August, pp. 225–238.

Steels for case nitrification. A. B. Kinzel. *Trans. Amer. Soc. Steel Treating*, August, pp. 248–254.

Inclusions in iron; a photomicrographic study. Part III, Sulphide inclusions. C. R. Wohrman. *Trans. Amer. Soc. Steel Treating*, August, pp. 255–299.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

Mortgages and Charges

*[NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.]*

ASIUM ALLOYS, LTD., London, E.C., metal founders.—Registered July 19, series of debentures, for £2,000, present issue £1,000; general charge.

BILBAO TIN SYNDICATE, LTD., London, E.C.—Registered August 2, £1,000 debentures part of £3,000 and premium of 15 per cent.; general charge.

BIRTLEY IRON CO., LTD.—Registered August 8, mortgage, to Bank; charged on properties at Birtley, etc.; also registered August 8, debenture (as collateral security for above mortgage up to £20,000), to D. M. Muir, 44, Grey Street, Newcastle-on-Tyne, and another, as nominees for Bank; general charge.

ESTLER BROTHERS, LTD., London, E., ironfounders.—Registered July 26, £50,000 mortgage, to Bank; charged on properties at Canning Town.

RODNEY FOUNDRY CO., LTD., London, S.E.—Registered August 7, £5,000 (not ex.), charge, to Bank; charged on Union Foundry and other properties at Deptford Green. *£7,701. October 12, 1927.

SOUTHERN FOUNDRIES (1926), LTD., Croydon.—Registered July 27, £1,930 supplemental mortgage to Corporation of Croydon; charged on properties at Merebank Lane, Croydon. *£70,000. January 12, 1928.

Satisfactions

BARR (N. J.), LTD., Leeds, iron and steel merchants.—Satisfaction registered July 24, £5,000 registered July 5, 1921.

MORRIS AND CO. (STOCKWITH), LTD., metal extractors etc.—Satisfaction registered July 19, £15,000 registered June 22, 1923.

London Gazette, &c.

Company Winding Up Voluntarily

NEW METALLURGY, LTD. By special resolution, August 3, confirmed August 20. F. A. Crew, 20, Copthall Avenue, London, E.C.2, Chartered Secretary, appointed as liquidator. Meeting of creditors at liquidator's office, Thursday, September 6, at 12 noon. Creditors' claims by September 29. All trade creditors have been, or will be, paid in full.

Monthly Metallurgical Section

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NOTICE.—Communications relating to editorial matter for our Monthly Metallurgical Section should be addressed to the Editor. THE CHEMICAL AGE, *Bouverie House, 154, Fleet Street, London, E.C.4. Communications relating to advertisements and other business should be addressed to the Manager. Contributions will be welcomed from correspondents on any points of interest to metallurgists bearing on works practice or current research problems.*

Some Notes on the Determination of Aluminium

With Special Reference to the Use of Hydroxyquinoline as a Reagent

By W. Singleton

ORTHO-HYDROXYQUINOLINE, or, as it is sometimes called, "oxine," in alcoholic or aqueous solution, has found numerous applications as an analytical reagent, and is a particularly valuable reagent for the detection and determination of aluminium. Practically all the metals which give a precipitate with ammonium hydroxide or sodium hydroxide solutions may be precipitated by means of hydroxyquinoline. For use as an analytical reagent, hydroxyquinoline (C_9H_7ON) may be prepared by recrystallisation of the commercial product from 50 per cent. alcohol. Its melting point is 76° C. It is slightly soluble in water, giving a yellow solution, its solubility being at a minimum at p_H 7·2, the iso-electric point.

General

Hahn and Vieweg (*Z. anal. Chem.* 1927, Vol. 71,122) have studied the use of hydroxyquinoline as an analytical reagent in the determination of aluminium, zinc and magnesium, and in the separation of aluminium and zinc from the alkaline earths, from magnesium and the alkalis, and of magnesium from the alkalis. The reagent forms inner complex compounds with aluminium, zinc and magnesium, and with tervalent aluminium the formula of the precipitate shows six closed rings, the hydrogen from the phenolic groups of three molecules of hydroxyquinoline being replaceable. Hydroxyquinoline is only slightly soluble in water, but it is distinctly more soluble in acetic acid and ammonia solutions. In strong acids, it dissolves to give quinoline salts, and in bases to form phenolates. The authors found that the metal precipitate is best obtained by adding the necessary amount of hydroxyquinoline solution to the neutral or faintly acid solution of the metal with subsequent heating on the water bath. Ammonium acetate (or ammonium hydroxide in the case of magnesium or beryllium) should be added to reduce the acidity. When the solution has cooled, the precipitate is filtered through a Gooch crucible, washed with dilute acetic acid (or ammonium hydroxide in the case of magnesium or beryllium) and finally with distilled water.

The precipitate is first dried for a short time at 105° C., and finally heated to constant weight at 140° to 160° C. With 0·4026 gram of magnesium sulphate ($MgSO_4, {}_7H_2O$), the theoretical weight of the magnesium hydroxyquinoline precipitate is 0·5081 gram. In twelve experiments made by the authors, the average result was 0·5096 gram, the lowest result being 0·5081 gram, and the highest 0·5106 gram. The low results were obtained when too large an amount of ammonium hydroxide was used. When zinc and magnesium are present together, the former is best determined by precipitation in dilute acetic acid solution, and the latter in the filtrate by adding ammonium hydroxide. The results obtained by this method show quite good agreement. Hahn and Vieweg, who examined the method when applied to the determination of aluminium, found that the result of fourteen experiments showed a maximum divergence of 0·26 per cent.

Bi- and Ter-valent Cations

When a bivalent cation is precipitated with hydroxyquinoline, two molecules of acid are liberated, and if a tervalent cation is similarly precipitated, three molecules of acid are formed. The acid thus liberated can be titrated with phenol red or α-naphtholphthalein as indicator, according to the method of Hahn and Hartlieb (*Z. anal. Chem.*, 1927, Vol. 71, 225). Any free acid that may be present is first neutralised, using methyl orange or any other similar indicator. After adding an excess of hydroxyquinoline, the solution is boiled gently for five to ten minutes. The phenol red is now added as indicator, and the solution titrated with 0·1 N sodium hydroxide until a red colour is developed, when the solution is immediately titrated back with hydrochloric acid until a pure yellow colour is obtained again, and 2 to 3cc. of acid added in excess. The solution is heated for 10 to 15 minutes to remove any base that was absorbed by the precipitate. The solution is now finally cooled, and titrated with sodium hydroxide until a red colour is again obtained.

As the titration is not affected by barium, aluminium and zinc may be determined together on one sample, and in another sample the zinc may be determined after the aluminium has been removed by precipitating with a barium carbonate suspension. The method requires care, as trouble may be encountered owing to the tendency of the precipitate to absorb small amounts of the base and possibly some indicator. It is frequently advisable to filter off the precipitate or allow it to settle completely, and then carry out the titration on a portion of the clear solution.

The presence of organic matter often makes the determination of aluminium difficult by the usual methods, as also does the presence of other cations whose salts are easily hydrolysed. Using hydroxyquinoline, aluminium may be precipitated in tartrate solution. The resulting aluminium precipitate is different from the quinoline salts of calcium, magnesium, zinc, and cadmium by being readily soluble in sodium hydroxide solutions, and unlike magnesium, a precipitate is obtained in the presence of dilute acetic acid. The aluminium precipitate may be weighed after drying at 110° C., or it may be ignited together with oxalic acid and finally weighed as alumina, Al_2O_3. It is also accurate to determine the hydroxyquinoline in the precipitate by bromimetric titration as in the case of the corresponding zinc and cadmium precipitates.

Details of the Aluminium Determination

Hydroxyquinoline precipitates aluminium as a crystalline, greenish yellow precipitate with the formula $Al(C_9H_6ON)_3$. The reaction is delicate, and according to Berg (*Z. anal. Chem.*, 1927, Vol. 71, 321–369), is sensitive in acid acetate solution to 1 part in 310,000, and in ammoniacal tartrate solution to 1 part in 178,000. In tartrate solutions containing sodium hydroxide, no precipitation takes place. The precipitation in acetic acid solution which permits of the separation from magnesium, alkaline earths and alkalis is proceeded with as follows. The cold, feebly acid solution of a volume of about 100c.c. is treated with 3 to 5 grams of sodium acetate and, whilst being stirred, with an excess of a 2 per cent. hydroxyquinoline acetate solution. The solution is warmed to 70° C, and filtered, the precipitate being washed first with a little hot and then cold water and then finally dried to constant weight at 110° C. (aluminium factor 0·0587). The oxyquinoline acetate reagent is prepared by triturating 3 grams of the base with 3c.c. of glacial acetic acid, adding 100c.c. of hot water and dilute ammonium hydroxide, drop by drop, until cloudiness commences, when the solution is filtered.

The aluminium precipitate, which is distinctly soluble in alcohol and acetone, is also somewhat volatile, and therefore the ignition of the precipitate to the oxide should be cautiously carried out, and preferably under a layer of about 3 grams of anhydrous oxalic acid.

Titration of the precipitate is the most convenient, quick and accurate method, and for this purpose the washed precipitate is dissolved in warm 10 to 15 per cent. hydrochloric acid and titrated with 0·1N bromate-bromide solution. (1c.c.0·1N =0·000225 gram aluminium). The precipitation of the aluminium from tartaric acid solution is carried out in the following way. To the solution, which should contain sufficient tartaric acid to prevent the precipitation of the aluminium hydroxide, 5 to 10 grams of ammonium chloride are added and the solution neutralised with ammonia. After warming a few minutes, the aluminium is precipitated by adding drop by drop a small excess of a 2 per cent. solution of hydroxyquinoline acetate. The solution will turn orange colour in the presence of excess of the reagent. 0·5c.c. of strong ammonium hydroxide is now added, the solution brought nearly to boiling for five minutes, allowed to stand for a few minutes, and filtered. Care should be taken to avoid a large excess of free ammonia, which would interfere with the reaction. Where it is required to separate quantities of aluminium not exceeding 50 milligrams from large quantities of magnesium, the following procedure due to Berg (*Z. anal. Chem.*, 1922, Vol. 71, 321, 369) is recommended.

The solution, of about 100 c.c. volume, is neutralised with sodium hydroxide until a slight turbidity appears, which is removed by the addition of a little acetic acid. The aluminium is precipitated at ordinary temperature with a 2 per cent. solution of hydroxyquinoline acetate. The precipitate is rendered crystalline by warming the solution, after which it is filtered, dissolved in dilute hydrochloric acid, and titrated bromimetrically. The filtrate is treated with a few c.c. of strong ammonium hydroxide, and the magnesium precipitated in the hot solution with slight excess of a 2 per cent. alcoholic solution of the oxyquinoline. The precipitate of $Mg(C_9H_6O_2N)_2.4H_2O$ is allowed to settle, filtered through a Gooch crucible, and washed with a dilute solution of ammonium hydroxide. After drying at 100° C. the precipitate may be converted to oxide after careful ignition under a layer of anhydrous oxalic acid, or alternately, it may be dissolved in 10 per cent. hydrochloric acid, and titrated with 0·1N bromate-bromide solution (1 c.c. =0·000304 gram magnesium), using thiosulphate, and a few c.c. of potassium iodide solution (20 per cent.).

To separate small amounts of magnesium from large amounts of aluminium, about 5 grams. of sodium tartrate are added, and the solution over-neutralised to the extent of 15 c.c. of 2N sodium hydroxide solution. The magnesium is precipitated with a small excess of the reagent in the cold, and the precipitate rendered crystalline by warming the solution. The solution is filtered when cold, and the precipitate washed with a faintly alkaline 1 per cent. solution of sodium tartrate. The magnesium precipitate may be converted to oxide by careful ignition or titrated bromimetrically.

Aluminium in Non-Ferrous Alloys

Small amounts of aluminium, when present in certain non-ferrous materials, may be determined according to the method of Lundell and Knowles (*Ind. Eng. Chem.*, 1926, Vol. 18, 60). The following method is recommended for the determination of quantities of aluminium ranging from 0·01 to 0·1 per cent., when present in non-ferrous alloys. One gram. of the alloy is dissolved in 5 c.c. of concentrated nitric acid, after which 30 c.c. of an 8 per cent. solution of sodium hydroxide are added, and the solution boiled for about a minute. To the solution is now added 8 c.c. of sodium sulphide solution, which is made by saturating the 8 per cent. sodium hydroxide with hydrogen sulphide, and diluting with an equal volume of the sodium hydroxide solution. The solution is thoroughly agitated by swirling around for a few minutes, filtered and made acid with 6N hydrochloric acid, 2 c.c. being added in excess. After digesting at 40–60° C. until the precipitate settles, the solution is filtered, and the hydrogen sulphide boiled off. The solution is made clear if necessary with a few drops of nitric acid, when 10 c.c. of 36 per cent. acetic acid and 5 c.c. of a 0·2 per cent. solution of aurin tricarboxylic acid solution are added. The solution is finally neutralised with a 10 per cent. solution of ammonium carbonate in 5N ammonium hydroxide and 5 to 10 c.c. added in excess. The colour of the red lake produced is compared with that produced with known amounts of aluminium. In the analysis of spelter, the above authors obtained good results, using a somewhat modified procedure entailing only one precipitation, details of which are given in the original paper.

Separation from Various Metals

When aluminium is precipitated by ammonia in the presence of much magnesium, the entrainment of magnesium by the precipitate of aluminium hydroxide which frequently occurs can be reduced to a minimum by careful adjustment of the degree of alkalinity. The precipitation of aluminium as hydroxide takes place preferably in a solution to which sufficient ammonium hydroxide has been added to give a p_H of 7, and it is not necessary to add much ammonium chloride, as has been sometimes recommended.

For the separation of iron and aluminium from zinc, the following method has been found useful. To the solution of the iron, aluminium and zinc, which should preferably be in dilute hydrochloric or nitric acid, dilute ammonium hydroxide is added until no further precipitation is evident. A slight excess of ammonium hydroxide is then added, followed by 100 c.c. of a cold saturated solution of ammonium carbonate, and sufficient distilled water to bring the volume up to approximately 400 c.c. It may be advisable in some instances to add about 2 grams of ammonium chloride at the commencement, to prevent the formation of a colloidal solution. After the addition of the ammonium carbonate, the solution is heated slowly to about 75° C. and then maintained at this temperature for five or ten minutes. The solution is now filtered, and the precipitate washed with hot water, dissolved in dilute hydrochloric acid, and the above procedure repeated. When ignited, the final precipitate yields ferric oxide (Fe_2O_3) and alumina (Al_2O_3). The zinc may be precipitated in the combined filtrates as zinc hydroxide by ammonium hydroxide after making the solution slightly acid and evaporating to about 400 c.c.

Separation from Beryllium

The following method for the quantitative separation of beryllium and aluminium has given very satisfactory results. It is based upon the different behaviour of beryllium from aluminium when tannin is added to a solution containing a considerable amount of ammonium acetate. Under such conditions aluminium is precipitated quantitatively, whereas beryllium remains in solution. If the reaction is used for the separation and detection of aluminium it is essential that both elements should be present in the form of sulphate. The procedure adopted is as follows. To the dilute solution ofthe beryllium and aluminium is added quickly a clear solution of ammonium acetate and tannin which has been heated to 80° C. This reagent is prepared by adding 3 grams of tannin to 100 c.c. of a cold, saturated solution of ammonium acetate. After the reagent has been added, the solution is boiled for a few minutes and filtered. Should less than 50 milligrams of aluminium be present in the solution, a paper filter is recommended for the filtration, but for larger amounts a sintered glass filter is preferable. The precipitate is finally ignited and weighed as Al_2O_3. Before proceeding to the precipitation of the beryllium in the filtrate it is necessary to destroy the organic matter present. This is accomplished by evaporating the solution with nitric acid. The beryllium is precipitated with ammonium hydroxide as beryllium hydroxide, and finally weighed as BeO.

A further method for the separation of aluminium and beryllium, which has the advantage of being simpler and possibly more rapid than the method using a tannin solution, has recently been described by Kolthoff and Sandell (*J. Amer. Chem. Soc.*, 1928, Vol. 50, 7, 1900). In this method an acetic acid solution of hydroxyquinoline is used for the separation of beryllium from aluminium and ferric iron.

Nickel in Non-Ferrous Castings

THE latest bulletin of the Bureau of Information on Nickel deals with "The Use of Nickel in Non-Ferrous Castings" (being Paper No. 1 of Series D). It deals with nickel brasses, both low nickel and high nickel (nickel silver), and complex nickel brasses; nickel bronzes (for high pressure work, steam and valves, bearings, and gears); nickel-aluminium bronzes; nickel in light aluminium alloys; and nickel-copper alloys. In every case a complete account of properties and applications is given. A table of typical compositions and a selected bibliography of the subject complete the pamphlet, which may be obtained on application to the Bureau at 2, Metal Exchange Buildings, Leadenhall Avenue, London, E.C.3.

Reflex Furnace Reduction of Oxides

By R. Saxon, B.Sc.

In the ordinary way, using a cast-iron pipe instead of combustion glass tubing, a temperature high enough to melt brass may be attained using the blowpipe. When the whole pipe gets sufficiently hot, a silica boat may be introduced containing the oxide, and coal gas sent through. This heated gas readily reduces copper, cobalt, nickel, iron, lead and bismuth, and, together with carbon, antimony. The best form of carbon is that in paraffin wax. A boat of this in the end of the pipe where the gas enters distils by heat and greatly assists the coal-gas. Some, of course, is mixed with the oxide.

For the more refractory metals, arrangements have been used to render the flame issuing from the pipe a Bunsen. Use is made of a long hood bent U shape, projecting beyond the end of the pipe, and lifted from it by coiled wire netting. A floor of asbestos is fitted in the end, reaching to the pipe-end. This slopes to allow the play of the blowpipe under a crucible held so that its top is played upon by the flame from the pipe, while the underside may be reached by the blowpipe flame. The use of the blowpipe takes away the luminosity from the pipe-flame, and its heat is reflected from the arched top into the crucible itself, without the possibility of air entering. There is no necessity to use a lid.

Two blowpipes may be used, one on either side of the crucible, the coal-gas flame playing between them. Such an arrangement makes it impossible to use baked clay crucibles, which expand and crack. Calcined clay, thin ones, are best, but their pores must be closed by roasting them after coating with resin, shellac, or aluminium paint. This fills some of their pores with carbon, which does not readily burn out. The aluminium may assist reduction if not first of all oxidised by roasting with or without nitre. The latter must be used sparingly, or the potash will dissolve out the aluminium oxide. However, when carefully introduced into the pores of calcined clay, there is no more serviceable crucible.

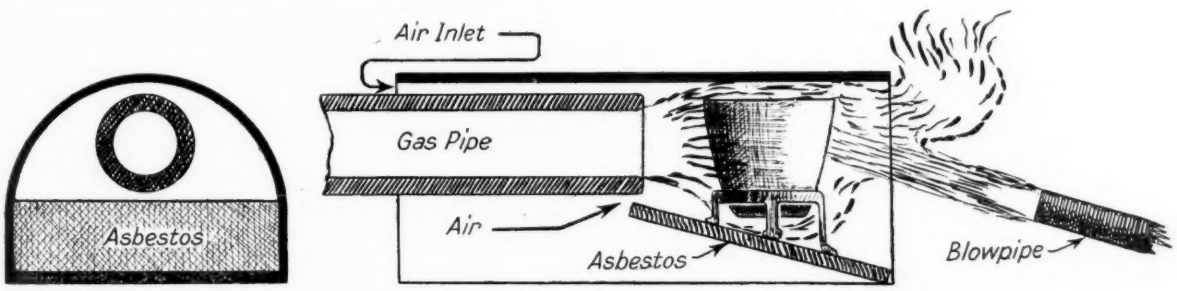
Manganese may be reduced by paraffin wax, but not easily. Chromium, vanadium, aluminium, etc., successfully resist reduction. Magnesium powder reduces manganese and chromium with comparative ease. The best flux with all these reductions is common salt with a little potassium chloride and hydrate. More than about 5 per cent. admixture of these does not assist fusion. As "seasoning," however, they do materially assist. For preliminary experiments thin calcined smoking clays are better than any other form of crucible. The stem forms an outlet for distilling wax and gases and finally closes up. The caustic potash does not attack it as it does silica, and one is not afraid of giving it generous heat on account of its cost. Thick ones invariably crack under the heat.

A determining factor in a number of reductions has been the tendency of lime to form calcium carbonate, even under roasting conditions. This was the lever used formerly to reduce potassium from the carbonate. For this reason crushed calcium carbide is employed in reducing manganese, chromium, zinc, magnesium, and aluminium from their oxides, and cadmium, iron and copper from the sulphides. The manganese decomposes water rapidly. Taking aluminium as an example, the following reaction takes place—

$$3CaC_2 + 3Al_2O_3 = 3CaO + 6CO + 6Al,$$

and although the carbonate does not appear here, it does with lower temperatures. The carbon monoxide can be seen burning at the mouthpiece end of the pipe. The whole is put into water to get rid of superfluous carbide and lime. When thrown into acid sufficient to deal with the undecomposed oxide, effervescence, or the lack of it, is an indication of probable success or decided failure as the case may be. On a larger scale the gas may be identified as hydrogen. If the carbide and wax be roasted together no carbonate results, nor can effervescence be obtained with acid. The presence of bubbles of gas, therefore, is a good suggestion of the presence of the metal.

The arrangement of the apparatus is shown in the accompanying diagram.



Arrangement of Apparatus.

Thermal Expansion of Aluminium

An investigation of the linear thermal expansion of pure magnesium, magnesium-aluminium alloys, and magnesium-aluminium-manganese alloys has recently been completed by the United States Bureau of Standards. Magnesium, the lightest structurally used metal, and its alloys are becoming more prominent for materials of construction where lightness and strength are important factors, for example in aircraft manufacture, and for moving parts of petrol engines. Expansion determinations were made on six samples of cast and extruded magnesium and 11 samples of cast and extruded magnesium alloys. The average coefficient of expansion of pure magnesium was found to be 0.0000260 per °C. between 20 and 100° C. The results obtained will be published by the Bureau of Standards.

Laboratory Uses of Monel Metal

Dr. L. F. Bates and Mr. R. C. Brown, of University College, London, in the course of a recent letter to *Nature*, point out that while Monel metal is a well-known article of commerce, its possibilities in the laboratory do not seem to have been realised. In the first place, as it is ferromagnetic and possesses such a low magnetic critical temperature, it may be conveniently used to illustrate the loss of ferromagnetism with rise of temperature. It also finds application in making jets for the determination of surface tension by Jaeger's method. It is particularly useful with mercury and molten metals which do not amalgamate with it. If glass is used, one is usually forced to rely upon a happy fracture in obtaining a satisfactory jet, but Monel metal may be drilled and turned to any dimensions with precision. After a few bubbles have been released, the pressure required to release a bubble becomes quite constant in the case of mercury at air temperature, a value of 477 dynes per cm. being obtained for the surface tension, assuming that the bubble is formed on the outer edge of the jet. This value agrees well with that obtained by other observers using the same method. Moreover, it is possible with a Monel metal jet to investigate the behaviour of the surface tension with temperature up to the boiling-point of the mercury.

Metallurgical Topics: Monthly Notes and Comments

From Our Own Correspondents

Programme of Institute of Metals

THE council of the Institute of Metals has just issued the new session's programme of the Institute and of its Local Sections in Birmingham, Glasgow, London, Newcastle-on-Tyne, Sheffield and Swansea. An outstanding meeting is that planned for March 6, when the "Coming-of-Age" celebrations of the Institute will be held in London under the presidency of Dr. W. Rosenhain, F.R.S. Another interesting feature is the Annual Autumn Meeting, which will be held in Dusseldorf in September.

The programmes of the six local Sections of the Institute are very comprehensive and cover, in all, 42 papers and meetings. Several of the papers will be discussed at joint sessions with other bodies, notably the Institution of Engineers and Shipbuilders in Scotland, the Institute of British Foundrymen, the Birmingham Metallurgical Society, and the Staffordshire Iron and Steel Institute. These joint meetings constitute an important new feature in the work of the Local Sections. First developed by the Birmingham Local Section, they have been extended by that Section to cover the whole of its programme of ten meetings during the session.

A novel meeting is the one arranged by the London Local Section to discuss "Some Present Day Metallurgical 'Tools' and Methods," the latter including the X-ray spectrometer, quantitative spectroscope analysis, high magnification microscopy, the dilatometer, and the preparation of some unusual metallographic specimens. Short addresses by various experts on each of these subjects will be given.

Altogether, the programmes suggest that the Institute exhibits a considerable amount of youthful vigour, notwithstanding its attainment of the age of twenty-one, and they should result in the further strengthening of its membership, which is now verging on the 2,000 mark. Copies of the programme and invitations to the meetings can be obtained on application to the Secretary, Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, London, S.W.1.

The Fuel Conference

A METALLURGICAL correspondent who attended the Fuel Conference writes as follows:—Some of those who attended the Fuel Conference were tempted to ask themselves whether conferences on this gigantic scale yield results to trade, industry and practical technology, at all commensurate with the expense, in time and money, which they must involve. Admitting freely that the conference was a very important affair, and very well organised and arranged, there is a point at which gatherings of this nature are apt to become unwieldy. There will be, in the published transactions of the Conference, a wealth of detail in which the expert can delve for information. The ordinary individual, seeking for definite information to help him in his own business or industry, will have no clue to the labyrinth, and will only be bewildered, amidst a host of disconnected papers, to find anything really useful or conclusive to him. Altogether, the three world power conferences hitherto held will have produced some 14,000 pages of matter. How many practical men who attended any, or most, of the twenty-two sections of the conference will have brought away with them anything definite to guide them to a decision as to whether coal, coke, gas, or oil is the better metallurgical fuel for their own specific purposes, or whether it would be better for them to scrap fuel and instal electrical smelting and annealing in their works instead?

Autumn Meetings

BOTH the Iron and Steel Institute of the Institute of Metals were better advised in this regard, that the papers down for reading at their recent Autumn meetings were reduced to a minimum and would not entail mental indigestion on the members attending them. In the case of the "Metals," the two discussions focussed respectively on two groups of papers. One dealt with corrosion, and the other, which was unusually brisk, animated and informative, with die-casting. The paper on "Die Casting Alloys of Low Melting Point" by Messrs. Russell, Cross and Allen, had much to commend it, pointing out, as it did, the effect of the many variables that enter into a successful accomplishment of the process. As Mr. A. H. Mundey said in the discussion, gating is one of the most important of the considerations involved, and, while no standardised form of gating is applicable, the particular gating needed for any particular type of casting is a matter that calls for skill and experience. Some criticism was made of the paper on "Die Casting Copper-Rich Alloys," on the ground that the aluminium-silicon alloys had not been done justice to in the comparative results published. Mr. Pearce made a point that there is insufficient information forthcoming as to the materials of which the dies are made, and held a brief for the heat-resisting irons for that purpose, as distinct from the heat-resisting steels often advocated. The life of the dies is obviously intimately connected with the nature and properties of the materials of which they are made, and as good dies are expensive and indispensible, more information on this point would be warmly welcomed by die-casters in general.

Direct Iron Processes

IT is understood that the inventor of the Duffield process repudiates the view that the process is a "direct" process in the ordinary sense of the term. This is to the good, as a large number of people are rather doubtful as to the potential merits of such processes. They have been innumerable, and it is, perhaps, difficult to draw the line as to where they end and so-called indirect processes begin. After all, early iron and steel makers were fairly successful in producing steely, or malleable, grades of iron by the direct smelting of iron ores with solid fuel, generally charcoal. Very good iron, too, they made, as is testified by many examples that have come down to our own times. It is true that the iron was made in small units, of the kind regarded as having fallen, nowadays, into desuetude. In these days of large-scale economic production in huge units, "mass production" as it is called, proposals to make iron in small units are looked at askance. It is held by some that there is no essential reason why iron, or indeed any other metal, should not be produced, economically, by small units; the qualification "economically" is, of course, the real crux of the whole matter, of which the question of large *versus* small units is, after all, secondary, and not necessarily the only consideration. A cheap small unit working efficiently may be just as responsive to the needs of industry as an expensive large unit working inefficiently, or part time only.

A Paradoxical Process

IT is quite possible to conceive of good iron and a valuable fuel gas being made in a slagging producer. Indeed, the blast furnace is a slagging producer, but it makes a poor gas, heavily diluted with the enormous amount of nitrogen which has, at great expense, to be supplied, along with the "active principle"—the oxygen—in the blast. No technical details of the Duffield process have as yet been made public, but it is said that the theoretical considerations upon which it is built are sound, and that provided the practical difficulties of carrying it out are surmounted, it should efficiently produce a high grade of iron at a low cost. It is on the lines, somewhat, of an ideal slagging producer of the kind to which reference has been made. The CO is produced by the combustion of low-grade fuel at the expense of the oxygen of the ore, without an extraneous "blast." Paradoxically, the materials are fed in at the bottom of the reducing chamber, and the resulting iron delivered at the top, the accompanying reactions consequent on reduction being practically in reverse order, chemically and thermally, to those which occur in the blast furnace. Until more is known of the process, its economic value cannot, of course, be affirmed. Despite a certain amount of scepticism which has been created by the withholding of more detailed technical particulars, it may be said that it embodies metallurgical possibilities of an exceedingly interesting order. After all, it would be foolish to imagine that existing methods of producing iron represent the last word in the metallurgy of that metal.

Metallurgical Analysis

THE latest edition of Lunge and Keane's *Technical Methods of Chemical Analysis* (Vol. II, Gurney and Jackson, price £3 3s. net) is devoted, in the main, to a description of methods employed in the analysis of iron and steel and of non-ferrous

metals, together with sections on the analysis of metallic salts, potassium salts, paints and pigments, and paint vehicles, japans and varnishes. The two metallurgical sections have been entrusted to Professor Bannister, which is, in itself, a guarantee that they are well done, and up-to-date. Yet an opportunity seems to have been missed of bringing the book as fully abreast of the needs of the day as is required. In these days of alloy steels, a voluminous literature has sprung up on the methods of estimating such constituents as chromium, vanadium, etc. and but little of the new material which is available has been incorporated in the text. This may be due to considerations of available space, as the amount allocated in the volume is insufficient to do the important subject of iron and steel analysis justice. As usual, too, the section on sampling is too casual. There is, moreover, a very dangerous statement made in regard to heaping up, halving and quartering the sample, in the stages of reducing its size and bulk. If only one of the " opposite quadrants " be taken (as appears suggested as permissible) an unskilled sampler would be absolutely at the mercy of a practised hand. Even a skilled sampler might, by using such a method, be deliberately or unconsciously vitiating the result. It would appear that the dodge of " drawing the cone " is less widely known to chemists than it is to professional samplers. Yet, without a true sample, how shall the best of analytical methods prevail ?

Tinplate Substitutes

A process of rolling aluminium-plated iron sheets has been loudly heralded in Germany, where aluminium is rapidly superseding some of the older metals in a number of applications. Many packing concerns are already using aluminium foil instead of tin foil, and in the tobacco and confectionery trades this practice is said to be rapidly gaining ground. The new development, however, is a more serious one still, and the South Wales tinplate manufacturers may find it a serious competitor. The tinplate trade is a fairly prosperous one, but complaints are not uncommon of a tendency to " skimp " the thickness of the tin coating. Of course, as in the case of so many metal coatings, a thin, porous, or indifferent coat is often, from a corrosion point of view, worse than no coat at all. The new German process of rolling on aluminium to mild steel or iron differs, of course, from the dipping of tin and galvanised sheets, and, although details have not been published, it appears to resemble more the process of rolling nickel on iron and steel. In that process the chief difficulty arises from the impossibility of rolling the nickel on to the edges of the base metal. How this difficulty has been solved in the case of the German process with aluminium-coated sheets is not disclosed. A " discontinuous " coat, as Mr. Ulick Evans showed at the recent meeting of the Institute of Metals, and as was, of course, known long before that, is a fertile source and cause of differential and intensified corrosion effects of the worst description. In any case, however, South Wales, which has just concluded a very satisfactory agreement with its American competitors in regard to world markets, will have to look to its laurels in regard to tinplate manufacture, and see to it that inroads are not made on its prosperity by the competition of the new " compound " plate.

Investigations of Ancient Metals

At the recent meeting of the British Association for the Advancement of Science, Professor C. H. Desch reported on an investigation which he had been making in order to determine whether examination of specimens of ancient Sumerian weapons would show whence the Sumerians drew their supply of copper. Some of the early copper specimens he found to be of remarkable purity, and he thought that the source must have been malachite, a mineral from which nearly pure copper can be smelted out, and which has so characteristic a colour and appearance that it could have been recognised easily by early workers. It was found, however, that many of the Sumerian relics in copper and bronze contained nickel as an impurity, and a long search was made for copper ores with nickel coming from Persia, the shores of the Black Sea, and the Sea of Marmora, Egypt, and Cyprus. These ores were found to be free from nickel, and only recently an ore accompanied by slack, showing that ancient smelting operations had taken place, and containing nickel, was found in the State of Oman. In the course of the examination of copper and bronze implements and ornaments, some iron objects found in very ancient deposits were analysed. It seemed probable that the very early implements had not been smelted from ore, but had been obtained from meteorites, either by chipping and hammering when cold, or by heating to a smelting temperature and then hammering to shape. As most meteorites contain nickel, the presence of the latter impurity in the iron instruments has significance. Analysis of a single iron object obtained from a grave at Ur showed a composition of about 90 per cent. iron and 10 per cent. nickel—in complete agreement with the composition of meteorites. An examination of an early iron bead obtained by Sir Flinders Petrie in Egypt, and often taken as proof of an early knowledge of smelting, also showed a meteorite origin.

Canadian Nickel-Copper Industry in 1927

According to a statement just issued by the Dominion Bureau of Statistics at Ottawa, mining, smelting and refining of the nickel-copper ores from the Sudbury district showed continued prosperity in 1927. More ore was treated by the smelters, a larger tonnage of matte was produced, and a greater production of refinery products was obtained than in 1926. The Creighton mine and the smelter at Coppercliff, Ontario, were operated without interruption during the year by the International Nickel Co., Ltd. On the Frood property, diamond drilling indicated high-grade ore at depth, and sinking of shaft was begun. At Port Colborne, Ontario, the nickel refinery was operated continuously to meet the market requirements for nickel. The new electrolytic unit ran to capacity throughout the year; it is understood that the company plans to enlarge its electrolytic refining department and eventually to produce electrolytic nickel entirely. In addition to electrolytic nickel, this refinery produces refined nickel, nickel oxide, metals of the platinum group, and converter copper carrying gold and silver which is exported to the United States for refining. Bessemer matte is exported directly from the smelter at Coppercliff to Huntingdon, West Virginia, for the manufacture of Monel metal.

Mond Nickel Activities in Canada

The Mond Nickel Co., Ltd., operated the Garson, Worthington, Levack and Frood extension mines and the smelter at Coniston, and utilized the Bessemer gases for the manufacture of high-grade sulphuric acid, for which a splendid market has been established. The Worthington mine, which has been in operation for about 20 years, caved in late in the year, but, fortunately, owing to the care exercised by the operating staff at the mine, no lives were lost. At this company's Frood extension property a deep shaft is being sunk to develop the large ore body indicated by diamond drilling. At the Clydach refinery in Wales, where the nickel-copper matte from the Coniston smelter is treated, the products are pure nickel, copper sulphate, gold and silver and the metals of the platinum group.

During 1927, the industry in Canada produced 1,305,917 tons of ore containing 27,564 tons of copper and 43,574 tons of nickel. The smelters treated 1,350,214 tons of ore and concentrates, and produced 81,848 tons of matte, which contained 51,937,215 pounds of copper and 79,246,144 pounds of nickel. Shipments of matte to the Canadian refinery amounted to 39,942 tons and export shipments to Great Britain and the United States for refining, totalled 33,541 tons.

Marking of Imported Copper

The Standing Committee of the Board of Trade under the Merchandise Marks Act, 1926, after considering an application respecting the marking of copper plate, sheets, strips, rods, wire and tubes, consider that the applicants (the Manufactured Copper Association, the High Conductivity Wire, Bars, and Strip Association, and the Brass and Copper Tube Association) have made out a case for an Order-in-Council requiring the goods to bear an indication of origin at the time of sale or exposure for sale. The committee does not recommend that the Order-in-Council should require the goods to bear an indication of origin at the time of importation or at the time of exposure for sale wholesale by a person being a wholesale dealer. The indication of origin, it is laid down, should be branded, embossed, incised, stencilled, or otherwise painted, stamped, or printed in a conspicuous manner. It is recommended that the Order-in-Council should come into force three months after the date on which it is made.

Trade, Commerce, Finance: The Month in Review

From Our Market Correspondent

THE end of the third quarter of the year has now been reached, and nobody is sorry to see the end of this period, which, from the standpoint of the iron and steel trades is the most unsatisfactory of the year. In this quarter, business is usually quiet, and orders are worked off faster than they are replaced by new ones. Nevertheless, everyone is once again looking forward to the closing months of the year in a hopeful spirit, which past experience seems unable to quench. It is too early yet to see what the autumn conditions are likely to be, as there are no indications of any definite change in the character or volume of business. In some of the special trades there has been a desire to contract ahead, but this may be accounted for by the necessity of renewing expiring contracts, rather than by the belief that an upward movement is likely to set in. Such a belief is not unknown at this time of the year.

It has become almost a tradition in the iron and steel trades that the last quarter of the year is the time when trade brightens up, a time of renewed activity in the markets, with a gradual improvement which may carry forward into the New Year. That has happened in the past, but more recently the change has not been very marked, and nothing more has occurred than a return to the uninspiring conditions which prevailed before the holiday season put its damper on trade. That may well be the experience this year.

Tone of Market Brighter

All that one can say, with any certainty, is that the tone of the market is a little brighter and that the volume of inquiry for business is increasing. It would, however, be unwise to infer that we are in for a busy quarter, or that we are likely to make great advances on the trade of the earlier part of the year. Prices are steady, and it is improbable that they will go any lower except in isolated instances.

The trouble is that there is no source to which to turn for any great increase in business. The steel works are now maintaining a production which compares very favourably with the good pre-war years, and the consuming industries do not promise any expansion which is likely to increase this production appreciably. It will be extremely difficult to expand the export trade to an extent which will materially affect production, as there is no easing of the fierce competition from other steel-producing countries, and export prices have reached such low levels that it would be a futile policy to make further reductions for the sake of catching orders. At the best, therefore, we can expect a little more activity and a healthier tone; or we may see a gradual settling down into the depressing conditions which have now become habitual, and which promise to be the natural state of the iron and steel trade until such time as some event happens which shall dispel this dullness and give the forward impulse which the industry needs. One would feel more hopeful if it were possible to point to some event or influence of this kind, but there is nothing in sight.

Safeguarding

It is the consciousness of this which accounts for the striking persistence in the demand for safeguarding. The claim for this assistance is being urged more strongly and more widely than ever. The opposition at present comes chiefly from the re-rollers and merchants, but it is significant that some of the most prominent of the re-rollers are now advocating safeguarding for the steel industry.

The merchants as a whole do not favour the proposal, as their treatment by the steel associations has not been encouraging. They are compelled to buy the controlled materials at the same prices as the consumer who buys direct, and the rebate scheme still further handicaps them and encourages direct trading between the user and the steel maker. It is natural, therefore, that the merchants will resist any policy which still further strengthens the hands of the steel makers, and closes or interferes with the one source of supply which gives them freedom of action.

Mr. L. D. Whitehead, in a recent letter to the press, stated that safeguarding appears to be the only real solution of the difficulties by which the iron and steel trades are at present beset. Unfortunately, even in the most favourable circumstances, it would be at least two years before this relief could become available, and it is distinctly unpleasant for the steel makers to think that they will have to carry their burdens so much longer. It is to be hoped that they will manage to hold out, but there may be some sorry financial wrecks by that time.

Rating Relief

The rating relief proposals seem to be taking more definite shape now that the revaluation of the works is being carried through. In most cases there has been a reduction in the assessment, and rightly so, as the level of values at the last valuation was much too high as compared with those of to-day. The three-fourths abatement on the new assessments will be a welcome relief when it becomes avialable, but it is probable that advantage will be taken of the state of the trade to force the transference of some portion of the benefit from the steel makers to the consumers.

In the stress of competition and the desperate need of orders there will no doubt be some makers who are willing to use this relief in reducing their prices in order to cut out some other maker. Some consumers are confidently expecting this. There have been definite instances where makers have been asked whether, in the event of the relief being granted, they will make a corresponding reduction in prices. It is conceivable that. to meet the foreign competition in the overseas markets, makers may have to use the rating relief in this way, but it is disturbing to find that home consumers are already expecting to grasp a share of it.

Coal and Coke

The coal trade seems to have reached the limit of its misfortunes and there are signs of a recovery. Prices are hardening as markets are recaptured. The export trade is improving, and there will be a better demand for home coal as the winter comes on. Even at present prices, most of the modern collieries could make a profit if they could work at full output, but the control scheme does not permit this. The scheme is not working too smoothly. There is much dissatisfaction amongst the members, and it would not be surprising if some were to break away. If that were to happen, the whole thing would break down. The tendency that way will become more marked as trade improves. The pig iron makers are severely handicapped owing to this control. There is a shortage of coke owing to the reduced supply of coking coal. None of the ovens are turning out their normal quantity, and the furnaces are short of supplies. Prices are advancing, and are 6d. to 1s. per ton higher for the coming quarter than for the last.

The pig iron market has been fairly steady during the month. Consumption has been scarcely equal to production, and consequently there has not been much disposition to contract forward. The last few days have seen a slight hardening in price, and this may develop. At the moment, the heavy stocks held by the makers will act as a deterrent to any serious advance in price.

The Steel Trade

In finished steel also the tone is better, but makers are badly in need of orders, particularly for plates. The bar trade is more brisk, and there is a better demand for bright drawing bars, notwithstanding the seasonal quietness of the motor trade. The constructional engineers are better off for work, and there is a fair demand for constructional materials. There is no change in the prices of the controlled materials. Small steel bars are rather better owing to the advance in continental prices. Boiler plates have weakened slightly as a result of the efforts which one or two firms are making to secure a larger share of this work. It is noticeable that more of the steel works are now turning their attention to these and to the better-priced materials such as deep stamping steel, and as the competition increases, prices will fall until even the special qualities will yield no profit.

The production figures for August show a further fall. There was a decrease of one in the number of furnaces in blast, and the output of pig iron fell from 537,800 tons in July to 519,000 tons in August. The output of steel was 648,300 tons compared with 666,900 tons in July.

Some Inventions of the Month

By Our Patents Correspondent

***Abstracts of other Patents of metallurgical interest will be found in our Patent Literature published weekly in* THE CHEMICAL AGE**

Alloys

To introduce molybdenum into iron or other metals or alloys a compound such as calcium moldybate is added to a molten bath or into slag thereon in which at least one constituent has a greater affinity for oxygen than has molybdenum. The molybdenum compound may, for example, be in contact with iron during an iron reduction or melting process. See Patent Application 293,860, bearing the International Convention date July 15, 1927, by the Climax Molybdenum Co., of New York.

A solder containing from 0.05 to 0.1 per cent. of lead phosphide in otherwise substantially pure lead is described in Specification 296,584 (Marks), dated October 20, 1927, a communication from American Machine and Foundry Co., of New York. 1 per cent. or more of a brightening metal, such as aluminium, antimony, tin, or zinc may be incorporated in the solder.

Antimony

PURE antimony is obtained by electrolytic deposition from a solution of antimony trifluoride containing 100–600 grams of sulphuric acid per litre together with a small amount of free hydrofluoric acid, the anodes being of crude antimony. The electrolyte is prepared from crude antimony or antimoniferous material by treatment with conc. sulphuric and hydrofluoric acids successively, followed by dilution and clarification. See Patent Application 294,143, bearing the International Convention date July 18, 1927, by Norddeutsche Affinerie of Hamburg, Germany.

Briquetting of Ores

ACCORDING to Patent Application 294,470, bearing the International Convention date, July 23, 1927, by E. A. A. Gronwall, of Stockholm, Sweden, iron and manganese ores are briquetted with powdered granulated iron, powdered carbon, and water, with or without an acid or salt and/or a slag-forming ingredient such as lime or chalk. For producing alloy steels, the briquettes may contain ferro-silicon, ferro-chromium, ferro-nickel, ferro-vanadium, etc.

Copper

A PROCESS for extracting copper from its ores by means of an ammoniacal solvent, such as a solution of cupric ammonium carbonate, is described in Specification 294,868, bearing the International Convention date, December 7, 1927, by Anglo-American Corporation of South Africa, Ltd., of Johannesburg. The ore is slimed, and the slimed pulp is dewatered and treated with the solvent. Preferably the dewatering is effected by filtering and forcing compressed air through the filter cake, and the solvent is then applied to the cake under pressure

Electrolytic Processes

THE inner lining of a furnace for the electrolytic production of light metals such as aluminium, comprises three superposed horizontal frames, viz., a bottom refractory or carbon frame containing the anode alloy, an intermediate insulating frame containing the electrolyte, and a top carbon frame containing the pure metal cathode insulated from the shell. The insulating frame is composed of electrolyte which has solidified upon a frame through which water is circulated. See Patent Application, 293,353, bearing the International Convention date, July 4, 1927, by Soc. Anon, Compagnie de Produits Chimiques et Electrometallurgiques Alais, Froges, et Camargue of Paris.

Iron

GREY molten cast iron is purified by addition of a silicide, *e.g.*, calcium or magnesium silicide, containing little or no iron, but containing in some cases a second alkaline earth metal such as barium and/or one or more of the metals nickel, aluminium, chromium, titanium, or vanadium. See Patent Application 292,164, bearing the International Convention date June 16, 1927, by Mechanite Metal Corporation of Chattanooga, Tennessee, U.S.A.

A PROCESS for the manufacture of steel in the Siemens-Martin furnace is described in Specification 293,326, dated December 24, 1926, by F. Siemens Akt.-Ges., R. Durrer, F. C. Siemens, and A. Sprenger, of Berlin. The process is characterised by the fact that, at least beginning with the completion of the fining process, a layer of gases practically free from hydrogen is formed between the bath and the heating medium, this layer serving to protect the charge from oxidation. Various arrangements for supplying the gases constituting the protective layer, and for regulating their quantity, temperature, and composition, are described and illustrated.

Lead

IMPURITIES such as arsenic, tin, or antimony, are removed from lead or lead alloys by bringing the molten metal, at a temperature below a red heat and in presence of molten caustic alkali, into intimate contact with an oxide of lead or of some other metal having less affinity for oxygen than that of the impurities present. Sodium chloride or other fusible chloride is in some cases added to the melt. See Specification 296,557, dated September 3, 1927, by H. Harris, of London.

Metallurgical Furnaces

B. TALBOT, of Middlesbrough, has applied for a patent of addition based on Specification 235,346 (see THE CHEMICAL AGE, Vol. XIII, p. 15 [Metallurgical Section]), the improvement being that the auxiliary baths of the open hearth furnace are made movable longitudinally in relation to the main furnace. For this purpose, as applied to a reversible regenerative tilting furnace, each auxiliary bath is mounted on rollers and arranged to communicate with the main hearth chamber through a throat structure formed with ports for the supply of gas and air from the regenerators, the joint being provided with abutting water-cooled chills, and the throat structure moving with the auxiliary bath when the latter is retracted to allow the furnace to tilt. See Patent Application 293,010, bearing the International Convention date June 30, 1927.

Reducing Ores

THE main object of the invention described in Specification 293,340, dated April 2, 1927, by P. R. Blamey, of Liskeard, Cornwall, is to effect the extraction of metals, particularly tin, from low grade ores or residues at a comparatively low temperature without formation of slag. For this purpose the ore or the like, after concentration if necessary, is subjected to a partial or complete reduction, and the product, in some cases after concentration by flotation, is washed in molten metal or alloy to remove the reduced metal. Such washing may be facilitated by the addition of a small quantity of resin or other flux. The metal remaining in the washed residue may be extracted by an acid or other reagent, or a gas such as chlorine, or by causing particles of the residue to slide down a channel-shaped electrode in an electrolytic cell, so that the metal is dissolved by the electrolyte and deposited on the cathode.

Tin

A PROCESS for the reduction of tin-bearing material is described in Specification 295,805, dated July 7, 1927, by E. A. Ashcroft, of Ashburton, Devon. During or after the reduction a catalysing or carrying salt and a collecting metal are added and the mixture is heated to cause the tin to alloy with the collecting metal, whereupon the alloy is separated and treated for recovery of the tin, preferably by electrolysis. Specified salts are zinc chloride, ferrous chloride, and ammonium chloride, and the preferred collecting metal is nickel which may be derived from the reduction of nickel oxide or hydroxide added to the charge.

Wet Extraction Processes

A CYCLIC process for obtaining metallic values from ores, concentrates, etc., by treatment to produce solutions containing the metals as nitrates is described in Specification 295,224, dated April 5, 1927, by S. C. Smith, of London. Such nitrate solutions are produced either (1) by leaching with nitric acid, or (2) by first producing from the ore, etc., in any known manner, a solution of sulphates and converting these into nitrates by double decomposition with calcium nitrate. In either case the solution of nitrates is treated with a calcium compound adapted to precipitate the metal values and reproduce a solution of calcium nitrate. The latter may be used again in method (2) above, or treated with an acid to regenerate nitric acid for use in method (1). Examples are given of the recovery of zinc and lead from a fume comprising zinc oxide and lead sulphate, and of the recovery of zinc and copper from a leaching liquor containing zinc and copper sulphates.

Current Articles Worth Noting

We give below a brief index to current articles in the technical Press dealing with metallurgical subjects.

ALLOYS.—Simple aluminium cast alloys. W. Claus. *Giesserei Zeitung*, September 15, pp. 529–536 (in German).

The use of nickel-chromium alloys as electric resistance heating elements in electric furnaces. A. G. Lobley. *The Mond Nickel Bulletin*, September, pp. 58–62.

The production of white bearing metals and tin.solders from scrap metals. Part I. Methods of purifying and mixing scrap to produce marketable alloys. E. R. Thews. *Metal Industry* (New York), September, pp. 394–396.

Aluminium brasses. E. R. Thews. *Canadian Chemistry and Metallurgy*, September, pp. 246–248.

Heat treatment of duralumin. L. Aitchison. *Fuels and Furnaces* (Pittsburgh, U.S.A.), September, pp. 1191–1194.

ANALYSIS.—The determination of small amounts of carbonate in presence of excess of sulphide and chloride, with particular reference to the analysis of metallic corrosion products. W. H. J. Vernon and L. Whitby. *J. Soc. Chem. Ind.*, September 7, pp. 255–259T.

Investigations into the analytic chemistry of tantalum, niobium, and their mineral associates. XII. Observations on the pyrosulphate hydrolysis method. W. R. Schoeller and E. F. Waterhouse. *Analyst*, September, pp. 467–475.

A new precipitation method for the determination of vanadium and its application to steel analysis. B. S. Evans and S. G. Clarke. *Analyst*, September, pp. 475–486.

ELECTROLYTIC PROCESSES.—Notes on the construction of plant for the electrolysis of fused materials. P. Drossbach. *Metall und Erz*, September, Part I, pp. 437–439 (in German).

Chromium plating fundamentals. P. E. Edelman. *Brass World* (New York), August, pp. 253–254.

The estimation of zinc pick-up in hot galvanising. E. D. Timmerman. *Canadian Chemistry and Metallurgy*, September, pp. 249–250.

FURNACES.—Highly refractory furnace linings. K. Heinrich. *Giesserei Zeitung*, September 1, pp. 508–513 (in German).

High temperature crucible furnaces; some points to be followed in building such furnaces. W. Mason. *Metal Industry* (New York), September, pp. 392–393.

GENERAL.—The chemistry of the cyanide treatment of silver ores. F. P. Raschig. *Metall und Erz*, September, Part II, pp. 467–477 (in German).

IRON AND STEEL.—Graphitisation of white cast iron by annealing below critical temperature. R. L. Dowdel and J. T. Gow. *Iron Trade Review* (Cleveland, Ohio, U.S.A.), September 6, pp. 570–571.

Hardness testing. H. M. German. *Trans. Amer. Soc. Steel Treating*, September, pp. 343–354.

The nature and application of the principal types of tool steel. W. H. Wills. *Trans. Amer. Soc. Steel Treating*, September, pp. 363–376.

Heating of steel by the controlled temperature method. G. W. Hegel. *Trans. Amer. Soc. Steel Treating*, September, pp. 377–384.

Inclusions in iron. IV. Oxide-sulphide inclusions. C. R. Wohrman. *Trans. Amer. Soc. Steel Treating*, September, pp. 385–414.

The dependence of the refining process in the Thomas converter on the temperature chart. R. Frerich. *Stahl und Eisen*, September 6, pp. 1233–1243 (in German).

The influence of tension and compression on the efficiency of high speed tool steel. R. Hohage and R. Rollet. *Stahl und Eisen*, September 6, pp. 1243–1247 (in German).

A new theory of the blast furnace process. II. F. Wüst. *Stahl und Eisen* (Dusseldorf), September 13, pp. 1273–1287 (in German).

A study of sulphur in the basic process. H. A. Geiger. *The Blast Furnace and Steel Plant* (Pittsburgh, U.S.A.), September, pp. 1201–1203. Deals with the sources of sulphur and the conditions of its elimination in the blast furnace, with special reference to temperature and slags.

Purifying steel with sodium compounds. J. R. Miller. *The Blast Furnace and Steel Plant* (Pittsburgh, U.S.A.), September, pp. 1204–1205.

The operation of the Siemens-Martin furnace with coke oven gas. G. Bulle. *Stahl und Eisen*, September 27, pp. 1353–1362 (in German).

Electrochemical behaviour and tendency to rust in chrome steels. O. Meyer and K. Roesch. *Stahl und Eisen* (Dusseldorf), September 27, pp. 1372–1373 (in German).

Comparative investigations of the tenacity of cast steel at raised temperatures. A. Pomp. *Stahl und Eisen* (Dusseldorf), September 20, pp. 1321–1330 (in German).

Recent developments in the application of nitrogen to the surface hardening of steel. V. O. Homerberg. *Fuels and Furnaces* (Pittsburgh, U.S.A.), September, pp. 1153–1157.

Prospecting for Minerals in Sub-Arctic Regions

EQUIPPED for a two years' stay in Canada's sub-Arctic regions and with aeroplanes for prospecting, a party of Canadian mining engineers and geologists has sailed from Halifax in the schooner *Morso*, bound for points in Hudson Bay. The expedition, which is sent out by Dominion Explorers, Ltd., is under the direction of Mr. C. H. Blanchet, exploratory engineer of the Canadian Department of the Interior, who is on leave of absence for the purpose. Equipped to be self-supporting and to venture beyond the tree belt into the so-called "barren lands," the expedition carries two "Fairchild" and two "Moth" aeroplanes, fitted with both pontoons and skis, besides specially constructed river boats known as "sturgeon heads" and snow-mobiles, or motor cars equipped with skis forward and giant flanger wheels on the rear axles. The engineers believe they will unearth mineral resources of vast value, which may be exploited with profitable facility on the completion of the Hudson Bay railway. Lieut.-Commander J. T. Randall, D.S.O., a retired officer of the British Navy, of Liverpool, Nova Scotia, is in charge of the *Morso*, a schooner of 400 tons, equipped with powerful auxiliary motors, wireless and modern navigation aids. Besides Mr. Blanchet, who has carried out extensive explorations in the Great Slave Lake district and easterly towards Hudson Bay, the technical staff includes Mr. J. C. Rogers, consulting mining engineer of Toronto; Mr. A. L. Reading, of Toronto; Mr. N. A. McKenzie, of Chatham, N.B.; Mr. Montague Prisk, of Schreiber, Ont.; Mr. Everett Rivers, of North Bay, Ont.; and Mr. J. Stevens, of Cochrane, Ont.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

Mortgages and Charges

*[NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case, the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.]*

ALUMINIUM CORPORATION, LD., London, S.W.—Registered August 20, £16,700 C. debentures part of £500,000; general charge. *£1,285,051 9s. 1d. December 30, 1927.

BILBAO TIN SYNDICATE, LTD., London, E.C.—Registered September 14, £1,000 debentures balance of £3,000 and premium of 15 per cent.; general charge. *Nil. June 6, 1928.

Satisfaction

BURROWS (S. H.) AND SONS, LTD., Sheffield, ironmasters.—Satisfaction registered September 12, £15,000, outstanding July 1, 1908, and registered December 12, 1910.

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NOTICE.—Communications relating to editorial matter for our Monthly Metallurgical Section should be addressed to the Editor. THE CHEMICAL AGE, *Bouverie House, 154, Fleet Street, London, E.C.4. Communications relating to advertisements and other business should be addressed to the Manager. Contributions will be welcomed from correspondents on any points of interest to metallurgists bearing on works practice or current research problems.*

The Extraction and Utilisation of Cobalt

By G. Malcolm Dyson, Ph.D., A.I.C.

In the following, Dr. G. M. Dyson adds an account of the production and uses of cobalt to the other articles from his pen which have appeared in this supplement.

THE history of the element cobalt appears to be intimately bound up with the early German mining legends. The majority of textbooks have it that the word "cobalt" is derived from the German "Kobold," but, in reality, the nearest approach to "cobalt" found in the writings of the ancients (Paracelsus, Agricola and "Basil Valentine") is the word "cobalus," which was the name of a spirit that, according to the superstitious notions of the times, haunted mines, destroying the labours of the miners, and often giving them a great deal of unnecessary trouble. In fact, at one time it was customary in Germany to incorporate into the Church service a prayer that "God would preserve miners and their works from kobalts and spirits." The name cobalt, then, became gradually associated with any mineral which from its appearance contained metal, but which mocked the efforts of the miners, and from which no metal could be extracted. It is not clear whether, in the first place, the miners actually associated the refractory nature of the minerals with the presence in them of a gnome, or whether they gave this name to the mineral out of joke, because it thwarted them as much as the supposed spirit.

Distribution

Cobalt is widely distributed in nature, but seldom occurs save in the presence of nickel, copper, arsenic and iron, a fact which has a considerable complicating effect on its metallurgy and extraction. Much of the commercial cobalt is obtained from the deposits at Cobalt City in Ontario, where a stretch of 70 miles of rich copper and silver ores containing cobalt and nickel surrounds Lake Timiskaming. The geological formation at this spot is very similar to that of the Western Highlands. Australian ores are also worked, the concentrates from the Cloncurry deposits in Queensland being refined, it is said, by the firm of Henry Wiggin at Birmingham. This deposit is exceptionally rich in cobalt, containing on an average 20 per cent. of this element, and has the advantage of containing very little nickel. An analysis of a "selected" sample gave :—

Arsenic	40·2 per cent.
Sulphur	15·8 ,,
Cobalt	33·1 ,,
Iron	2·1 ,,
Silicon	8·3 ,,

Many other ores of cobalt are known, among the more interesting of which we may mention the following :—

NAME.	FORMULA.	NATURE.
Erythrite	$Co_3As_2O_8.8H_2O$	Hydrated cobalt arsenate
Linnæite	Co_2S_4	Cobalto-cobaltic sulphide
Smaltite	$(Co.Fe.Ni)As_2$	Impure cobalt diarsenide
Cobaltite	$CoS_2.CoAs_2$	Cobalt sulpharsenide
Glancodot	$(Co.Fe)AsS$	Iron-cobalt sulpharsenide
Spacerocobaltite	$CoCO_3$	Cobalt carbonate
Skutterudite	$CoAs_3$	Cobalt triarsenide
Willyamite	$CoS_2.NiS_2(Co.Ni)Sb_2$	Cobalt-nickel sulphantimonide
Asbolite (Cobalt wad)	$(Co.Mn)O.2MnO_2.4H_2O$	Hydrated cobalt-manganese oxide

There are, therefore, three ways in which cobalt concentrates are produced, affording three types of raw material for the manufacture of cobalt and its compounds. The first consists of high-grade cobalt minerals (*e.g.*, the Cloncurry ores), containing but little nickel; secondly, the residues from the Mond process for the extraction of nickel, containing cobalt, much iron and very little nickel; and, lastly, the residues from the Canadian minerals, in reality the by-products from the extraction of gold and copper. These contain almost equal amounts of cobalt and nickel, as is shown by the analytical data below :—

	RESIDUES.	SPEISS.
Cobalt	7·86	17·55
Nickel	6·59	18·85
Iron	8·43	12·04
Copper	—	8·15
Silica	—	—
Silver	0·47	0·91
Sulphur	—	6·69
Arsenic	—	35·14

Extraction of Cobalt

As might be expected, the method of extraction depends on the raw material to be worked up, and in nearly every case depends on the elimination of arsenic from the material and the separation of cobalt from nickel. In the older process for the treatment of the residues above, or of cobalt-nickel minerals, the residues or ground mineral is smelted in a low-pressure blast furnace or cupola with the addition of various minerals to slag off the siliceous materials. Lime is added to a melt which is originally high in silica, and sand to a mineral that contains much lime, the quantity to be added being determined by an assay of the ore; in addition, a little fluorspar is added to cause the slag (which is mainly calcium silicate) to run well. The arsenic and sulphur present combine with the iron, nickel and cobalt present, forming a heavy "speiss," which sinks through the melt and forms a heavy layer at the bottom of the furnace, and, incidentally, in its passage through the furnace, helps to "extract" any cobalt from the melt, in much the same way as an organic solvent extracts a soluble substance. The speiss so obtained is tapped off, and is for practical purposes considered as a mixed arsenide of iron, cobalt and nickel. The next stage in the operations is the removal of the arsenic, to which end the speiss is finely ground and calcined in a mechanically-stirred rabbling furnace. Much of the arsenic is volatilised as the trioxide, and long fume ducts are necessary to effect the complete condensation of this by-product, which is, of course, sold as the white arsenic of commerce. The speiss, which by this time has acquired magnetic properties, contains, after roasting, about 10 per cent. of arsenic, whilst the amount of cobalt depends on the nature of the original ore. Calcined speiss from Canadian residues contains about 20 per cent. of cobalt, with a fair amount of nickel; the calcined speiss from Cloncurry ores average 35–40 per cent. of cobalt, with a correspondingly smaller amount of nickel.

Further treatment of the concentrates is almost purely chemical, and involves two distinct stages: (*a*) the removal of the residual 10 per cent. of arsenic; and (*b*) the separation of the cobalt and nickel. The removal of the arsenic is effected through the medium of ferric arsenate. The ground and calcined speiss is treated with hydrochloric acid and live steam. The copper, cobalt and nickel present are converted to their respective chlorides and the arsenic to arsenic acid. The arsenic acid appears as iron arsenate, which is soluble in dilute hydrochloric acid; if insufficient iron is present in the original speiss to convert all of the arsenic acid to the ferric salt the requisite amount of ferric chloride (determined by assay) is added to the reaction liquid, which is at this stage

allowed to settle and the clear liquid decanted from insoluble impurities. Milk of lime is added to the liquid until neutral, a proceeding which throws the ferric arsenate out of solution. Filtration at the press follows, and the solution, now almost freed of arsenic, is treated with hydrogen sulphide to remove any traces of this element, and also any copper that may be present.

Separation of Nickel and Cobalt

The separation of nickel and cobalt is done by means of the addition of sodium hypochlorite, a process which we owe to the discovery of Charles Askin, a native of Cheadle, Cheshire. About 1788 this gentleman, a veterinary surgeon practising in Birmingham, had adopted metallurgy as a hobby, and it was during a visit to Warsaw that he became acquainted with the metal nickel. On his return to this country he determined to experiment on its alloys. He succeeded in obtaining a form of German silver, when his supply of nickel ran out, and since that element was not at the time a commercial commodity, he was forced to extract more of it from its ores. The only ore that was available to him at the moment contained a substantial proportion of cobalt, and he was faced with the task of separating these two elements. Before setting about it he consulted with one Benson, the manager of a local chemical factory (and, incidentally, the father of a recent Archbishop of Canterbury), who was interested in the production of cobalt for ceramic purposes. Neither Benson nor Askin were conversant with any process for the separation, and both agreed to attempt the problem. It was suggested that bleaching powder solution should be used as a first attempt: Benson dissolved up his portion of the mineral, and on adding an excess of the reagent found that both metals were precipitated; Askin, on the other hand, after dissolving up his share of the mineral found to his chagrin that only half the necessary amount of bleaching powder solution was at hand; in despair he added this limited quantity, and found, to his surprise, that cobalt oxide was precipitated, comparatively free from nickel. This separation is the basis of modern commercial methods. To the clear solution after the removal of the arsenic, iron and copper, sufficient calcium hypochlorite solution is added to precipitate the cobalt as the hydrated oxide, according to the reaction :—

$$2CoCl_2 + CaOCl_2 + 2Ca(OH)_2 = Co_2O_3 + 3CaCl_2 + 2H_2O$$

The oxide comes down as a black precipitate, which has a composition closely approximating to $Co(OH)_6$. The filtered oxide is dried and calcined gently, after which it contains about 76–77 per cent. of cobalt (calculated as the element). Nickel oxide is obtained from the filtrate after the separation of cobalt by precipitation with milk of lime. It is treated to remove the calcium salts with which it is contaminated, and dried and calcined in the same way as the corresponding cobalt compound. Three grades are recognised :—

	% of Ni
"OG" Ordinary Green	68–70
"G" Green	73
"DR" Double Refined	73–76

Alternative Methods

On rare occasions, when cobalt ores free from nickel are being treated, the separation from nickel is, of course, unnecessary, as also in the preparation of cobalt from Mond residues. In the latter case the nickel has been removed as the volatile carbonyl, and the cobalt remains in the residues. The separation of nickel in the Mond process, is not, however, quite complete, and a small quantity of nickel is obtained in solution as well as the cobalt. This is usually ignored, as the cobalt oxide from this source is usually intended for the production of ferro-cobalt, in which the presence of a small percentage of nickel is not undesirable. There is, however, one disadvantage of the Askin separation of nickel and cobalt, in that it is incomplete; no matter with what care the process is carried out, the final product always contains nickel to the extent of one or two per cent.; furthermore, the process is somewhat costly to operate.

In view of this, and also of the demand for pure cobalt compounds free from traces of nickel, an alternative process has been devised which utilises the extremely interesting co-ordination compounds of cobalt. An account of the chemistry of cobaltammines cannot be given here, but it may be mentioned that if a solution containing cobalt chloride and an excess of ammonia be treated with hydrogen peroxide, or even by aerial oxidation, a complex ammine of the aquopentammine series is produced. This substance, aquo-pentammine cobalt chloride, $[Co(NH_3)_5.H_2O]Cl_3$, has received the name roseocobalt chloride. If this substance be boiled in aqueous solution it becomes converted into chloropurpureocobalt chloride, the systematic name of which is chloropentammine cobalt chloride, and the formula of which is $[Co(NH_3)_5.Cl]Cl_2$. The latter compound is not markedly soluble in water (one part in 287 at 10° C.), and taken together with the fact that no corresponding nickel compound is formed, offers a means of separating cobalt from its sister element. The extraction takes the same course as that described above until the iron- and arsenic-free solution is obtained. This is treated either with commercial hydrogen peroxide, or by air in multiple jets and under considerable pressure, after having been rendered alkaline by a large excess of strong ammonia. After a few hours' treatment, the roseocobalt chloride solution is obtained, and is boiled, when the purpureo compound is precipitated. Since the product is even less soluble in dilute hydrochloric acid than in water, this reagent is used for washing the product.

The cobalt oxide is readily obtained from its purpureo compound by boiling with lime. Ammonia is evolved, cobalt oxide is precipitated and calcium chloride goes into solution. In this way cobalt oxide may be obtained which is analytically free from nickel, whilst in addition it may be noticed that the ammonia performs a cycle of operations, and may be used over and over again. The only cost is that of oxidation of the alkaline cobalt solution, and the consumption of hydrochloric acid.

Metallic Cobalt

The metal cobalt has many properties which are similar to those of iron. In colour it is grey, but with a distinct pink tinge that can be observed very easily by multiple reflection. It is magnetic up to 1,100° C., and its mechanical properties are given in the table below :—

Property.	Cast.	Annealed.
Specific Gravity	8·77	8·92
Brinell Number	—	121
Melting point	1,478° C.	—
Tensile Strength	15·35 tons/sq. in.	—
Compression Strength ..	54·5 tons/sq. in	—
Specific Heat 15-100° C. ..	0·105	—
Resistance (Electrical) ..	—	8·96 microhms/cc.

The metal is improved by mechanical working, and rolling has been shewn to improve the tensile strength, this value having reached 44·6 tons/sq. in. for swaged wire. As in iron, the presence of carbon improves the mechanical qualities also, 0·3 per cent. of this element being able to double the tensile strength. Plating with cobalt is an operation that can be performed quite easily. The two solutions which have found most favour are (*a*) a saturated solution of cobalt ammonium sulphate (containing 200 g. of $CoSO_4.(NH_4)_2SO_4.6H_2O$ per litre) and (*b*) a solution of cobalt sulphate (312·5 g.) and sodium chloride (19·6 g.) in a litre of saturated boric acid solution. The actual deposition of cobalt is much more rapid than with nickel, in spite of which the resultant coating is more adherent. The fact that cobalt is much harder than nickel makes the coating able to stand longer wear, and also brings up the polish with less buffing than with nickel. The colour of the metal, which is much less brilliant than that of nickel, militates against its use for ornamental finishing.

Cobalt Alloys

Cobalt *per se* has practically no uses, and it is only in the form of its alloys that it has an interest for the metallurgist. The metal itself may be obtained by smelting the oxide with charcoal in a small blast furnace, but it is usual to smelt in this way only the oxide containing ferric and nickel oxides as impurities. In this way a ferro-cobalt containing 80-90 per cent. of cobalt may be obtained, and it is this that is used in the formation of the various cobalt steels. The cobalt steels are, perhaps, the most important alloys of cobalt, and the Co-Fe equilibrium diagram is shewn below in Fig. 1.

The valuable properties of cobalt steels lie, not so much in their toughness and tensile strength (which are, nevertheless, quite considerable) but in their electrical properties, which make them eminently suitable for the manufacture of magneto

magnets. The most desirable characteristic of a permanent magnet to be used in this way is a high coercive force (H), so that it cannot easily be demagnetised. It was two Japanese

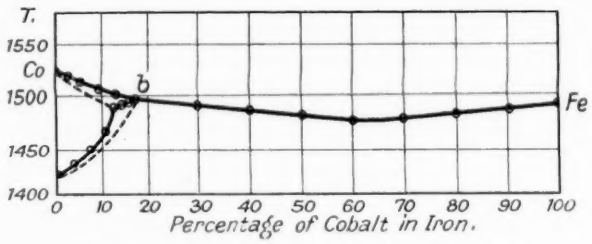


FIG. 1. COBALT-IRON EQUILIBRIUM DIAGRAM.

metallurgists, Honda and Tagaki, who first pointed out that the presence of cobalt in steel up to 35 per cent. increased the value of " BH " (B the flux density ; H coercive or demagnetising force). The nature of this increase is shewn in the Fig. 2 below.

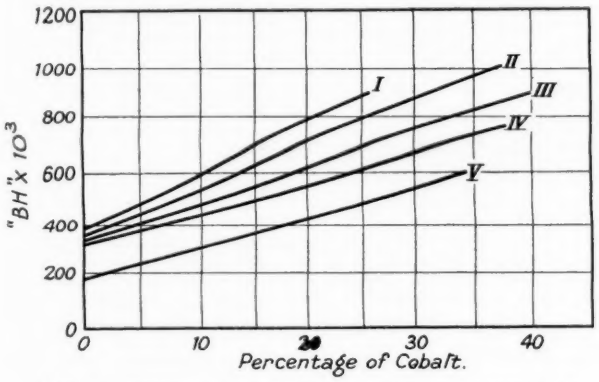


FIG. 2. INCREASE OF " BH " VALUE WITH PERCENTAGE OF COBALT IN STEEL.

I. High alloys steel.
II. Triple heat-treated medium alloy steel.
III. Medium alloy steel.
IV. Low alloy steel.
V. Straight carbon steel.

The various types of steel (excepting, of course, the straight carbon steel, which is only included for comparison) all have approximately the same " BH " value in the absence of cobalt, namely, 300–400, and it is readily obvious from the above diagram that the alloying with cobalt greatly increases the " BH " value, until with the steel II there is attained a value of approximately 1×10^6 with 35 per cent. of cobalt. The various types of steel used respond somewhat differently to the alloying process, and it is of interest to summarise their chief characteristics. IV is a low alloy steel, and is represented in the table below by A and B, both quoted from figures by Hadfield ; III is a medium alloy steel, of medium carbon content, quoted from Gant, while II is a steel which has been treated specially to improve its permanence ; its analysis is very similar to that of III. The heat treatment is applied in three stages.

PROPERTIES OF STEELS SHOWN IN FIG. 2.

	A	B	III
Remanence	9,900	10,150	—1·0
Coercive force	97	130	—
BH	375,000	550,000	850,000
ANALYSIS—			
Carbon	0·52	0·52	—
Silicon	0·29	0·25	—
Phosphorus	0·046	0·024	—
Sulphur	0·058	0·043	—
Manganese	0·42	0·57	0·1
Chromium	2·2	1·85	5·5
Nickel	0·51	0·16	—
Tungsten	8·0	7·82	4·0
Cobalt	8·89	17·77	36·0

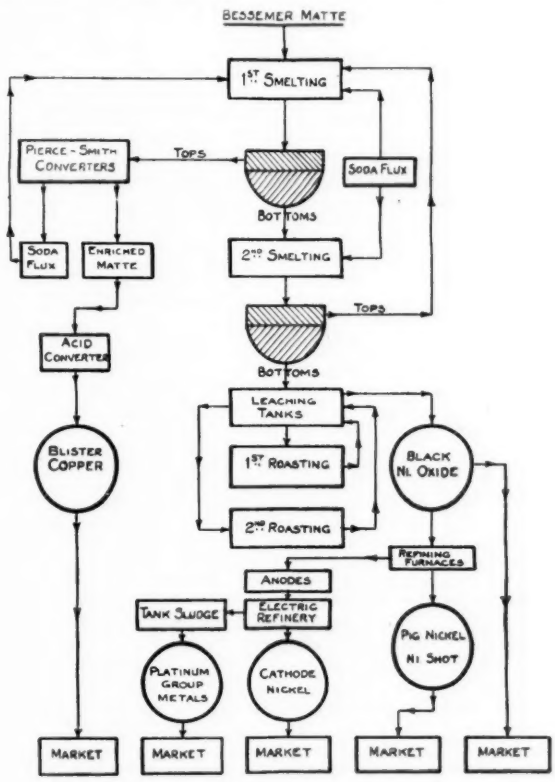
The bar is heated to 115° C. for five minutes, and allowed to cool in still air. During this process the bar becomes almost non-magnetic, since the structure is mostly austenitic. In the second stage the bar is reheated to 700° C. At this point pronounced recalescence sets in, and the temperature rises spontaneously to 800° C. The bar is cooled slowly. The third stage consists merely of heating up to the hardening point. So far, this steel has not been improved upon for the construction of permanent magnets.

(To be concluded)

The International Nickel Company

Its Products and Activities

IN view of the interest which has been aroused by the discussions between the leaders of the Mond Nickel Co. and the International Nickel Co., it is of interest to note some of the activities of the latter firm. Among its products (sold under the name " Inco ") are the following : electrolytic nickel



FLOW SHEET OF PRODUCTION OF NICKEL BY THE INTERNATIONAL NICKEL CO. OF CANADA, AT THE WORKS AT PORT COLBORNE, ONTARIO.

(containing 99·95 per cent. of nickel—including 0·3-0·4 per cent. of cobalt—0·4 per cent. of iron, traces of carbon, silicon, and sulphur, and 0·3 per cent. of copper) ; nickel shot (containing 99·65 per cent. of nickel, with cobalt as above, and small amounts of iron, carbon, silicon, sulphur and copper) ; " F " nickel (containing 91·75 per cent. of nickel, with cobalt as above, 1·8 per cent. of iron, and 5·75 per cent. of silicon)—this is used for addition to cast iron ; and nickel ingots (containing 99·2 per cent. of nickel, with cobalt as above). In addition, " Inco " products include nickel oxides (green and black), and reduced nickel. The International Nickel Co.'s method of working up Bessemer matte is shown in the accompanying flow sheet, which illustrates the mode of operation at the works of the International Nickel Co. of Canada, Ltd., at Port Colborne, Ontario.

Metallurgical Topics: Monthly Notes and Comments

From Our Own Correspondents

Institute of Metals Meeting

A SPECIALLY interesting meeting of the London Local Section of the Institute of Metals has been arranged for Thursday, November 8, at 8 p.m., when Professor W. E. Dalby, F.R.S., will give an address at the Royal School of Mines, South Kensington, S.W.7, on "The Plastic Contour." The work of Professor Dalby on the mechanical properties of materials is so well known that the lecture is bound to attract a large audience. It is understood that the lecturer will deal with the development of the instruments which he has devised for the examination of the mechanical properties of materials. He will also describe the results of his tests, and discuss some of the problems which arise when a metal extends or contracts under stress. The lecture should appeal to all concerned with the manufacture or use of metals. The meeting is an open one, for which tickets can be obtained on application to the Hon. Secretary, Mr. W. T. Griffiths, M.Sc., F.I.C., c/o The Mond Nickel Co., Ltd., Victoria Station House, London, S.W.1.

Polishing Problems

THE paper on "Polishing Materials" read by Mr. Wright before the last meeting of the Electroplaters' and Depositors' Technical Society, initiated a discussion which might have lasted until midnight if the chairman, Mr. Macnaughtan, had not mercifully applied the guillotine. Opinion was divided as to the part played by sharp-edged abrasives in polishing surfaces, and that of rounded particles, exercising a burnishing rather than a cutting action. The author was of opinion that the degree of heat developed in polishing operations is not only much greater than is usually believed, but that it plays a very important part in flowing the surface. On the other hand, the experiences of some of the speakers were rather to the effect that some of the finest polish finishes, attained by hand, lead to little heat being produced at all. Cartaud did some good work years ago on research in polishing, which Sidney translated in the third edition of Osmond and Stead's well-known book, but the literature of the subject is still somewhat scanty. There is some evidence to show that while burnishing induces a flowed material of the kind to which Beilby applied the term amorphous, this is by no means the same as the smooth, unflowed and *naked* surface which can be, and is, more usually developed in ordinary cases of polishing, when burnishing operations are reduced to a minimum and the surface is really the surface of the metal itself, in a normal as distinct from an amorphous condition.

Corrosion of Light Alloys

MR. SUTTON'S paper on "Light Alloys in Aeroplane Construction from the Standpoint of Corrosion," read before the Royal Aeronautical Society, rather failed in its effect, if that effect was to discuss more particularly the mechanism of intercrystalline corrosion. That issue was practically lost sight of in the subsequent animated discussion. Mr. Sutton had illustrated his paper by a number of shocking examples—one of the speakers called them "gruesome"—and indeed the whole paper might have been construed into an attack on duralumin. Now that metal is all that a light alloy can be: strong, light, durable and effective in its applications, on the simple condition that it is properly treated. No metal can be expected to stand up properly otherwise, and this Dr. Aitchison promptly showed when he, in turn, stood up for it. He did not attempt, as he might quite legitimately in the circumstances have done, any special pleading on its behalf. It is possible that Mr. Sutton may have more direct evidence than he adduced in his paper as to the bad behaviour of light alloys—he attacked them pretty generally all round. So far as the paper itself was concerned, the evidence was not forthcoming. Magnesium, too, fared badly at his hands, but it, too, found its defenders. The paper was rather sweeping, and metallurgists will want to know a good deal more as to the conditions to which Mr. Sutton's specimens had been exposed before they can accept his results as at all typical of the general behaviour of light metals and alloys when exposed to normal corrosive influences.

Intercrystalline Corrosion

THE general view expressed in the discussion was that intercrystalline corrosion is hardly likely to take place to any considerable extent without plainly indicating its occurrence by surface manifestations. Although Mr. Sutton did not actually say so, it might be inferred that some at least, and probably the worst, of his specimens, were the result of accelerated tests. These are always suspect, so far as they afford any real clue to what may be expected to happen to a metal in normal use, and just as they tend to intensify surface corrosion, so they tend to intensify, perhaps in an even greater degree, intercrystalline corrosion. As this affects profoundly the fatigue limit of the metal it is, however produced, a legitimate subject of research. At the same time, greater discrimination is needed in applying the results of such tests, and Mr. Sutton's remarks have far too wide an application—wider, it may be believed, than he actually intended. It is well to know the worst about our metals, but merely to know that, under bad treatment and abnormal exposure to corrosive influences, they occasionally fail, or even disintegrate, will lead us nowhere. We want to know how they compare, fairly, with other metals, in similar conditions of actual service, not under accelerated and altogether abnormal tests of the kind too often employed.

Pig-Bed Moulding Machine

IRON founders do not, in this country at least, care for pig iron cast by machine into chill moulds. It is true that it is free from sand, which adheres so pertinaciously to the ordinary sand cast pig, but the chilling alters the balance between combined and graphitic carbon, and disguises or confuses the grade, and although grading by analysis alone is often advocated, the typical foundryman does not like it. However, it has always been recognised that there are many disadvantages attending the production of sand-cast pig from the open pig beds in vogue at most blast furnaces. The making of the bed involves much costly labour that could well be dispensed with, and the result is not as satisfactory as it might be. There is a great element of empiricism about the whole operation. In the result that enterprising German firm, "Demag," has devised a machine which is a notable contribution to blast furnace practice. It enables the pig iron to be cast in open sand beds, in the manner dear to the founder, and yet secures uniform pigs with a minimum of sand, and in a form convenient for breaking and loading up. This is accomplished not by machine casting, but by a machine for laying the bed and thus doing away with the expensive hand labour hitherto employed for this stage of the blast furnace cycle of operations.

Mode of Operation

THE machine runs on an elevated track over the pig bed, or beds, in front (tapping side) of the blast furnaces. It performs two functions. First, it rakes the bed, by a system of ploughs, which thoroughly turn over and mix the sand of the bed into which a cast has just been tapped, and from which the pigs have been removed. Then, on reversal, it smooths and dresses the sand along the ploughed up strip, and subsequently traverses it again, and presses into it a set of patterns, which are lowered firmly, steadily, and to the proper depth, thus automatically making both the sow and the comb moulds of uniform and exact size. It repeats the operations on each strip, and thus produces a firm and level pig bed with ease and rapidity, the intervening walls being all of uniform thickness and pressed to a uniform degree of compactness. A special device has been adopted to raise the patterns without damaging the moulds, and allowing loose sand to fall back into them. The machine itself runs back, and is housed at either end, to await the next time it is required. It has a further advantage; that the patterns can be made so as to make a depression across the middle of each pig, to facilitate breaking, and a similar depression at the neck, where the pig is joined to the sow. Only half an hour is required for the whole operation of dressing and moulding the bed for a cast of 50 to 60 tons, and only two men are required for its operation. Less scrap

is made and cleaner pigs, although it is obvious that such a machine can only realise its fullest economic possibilities on plants where there are a number of furnaces in blast.

The Nickel Merger

LAST week a statement, which was at first regarded as official, was issued with regard to the terms of some kind of merger or arrangement between the Mond Nickel Co. and the International Co. No confirmation, however, was forthcoming from the Mond Nickel Co. The latest news on the subject is a cablegram sent by Lord Melchett, chairman of the Mond Nickel Co., who has just returned from the United States. Lord Melchett's statement is as follows :—

"I have been asked to furnish some comment on a statement issued by Mr. Hayden, chairman of the board of the International Nickel Co. As Mr. Hayden states, there have been a number of conferences between us and leading Canadian stockholders regarding the question as to whether it is not possible to create a closer co-operation, through the medium of a Canadian company, between the various interests which are operating the nickel industry in Canada and Great Britain. I have recently been inspecting the properties of the Mond Nickel Co., at Coniston, Canada. In addition to the extremely satisfactory position of the operating mines, I have been considering the development of the Mond Frood Mine. This mine, on which development has been proceeding for some years, is showing very satisfactory results. In view of the growth of the nickel consumption in the world, in which the Mond Co. has a very considerable share, future developments have to be provided for, and my company has accordingly made an issue of shares recently providing itself with about £2,000,000 new money for the purpose of development in Canada and Great Britain. It is well known that the International Nickel Co. are developing their section of the Frood property and are also preparing for a large capital expenditure. Sections of the Mond and International Nickel Co.'s Frood mines are, in fact, adjoining parts of the same mine and are, in both cases, the chief sources of supply of ore for the future.

The Broad View

"To anyone who is used, like myself, to looking at industry in a large economic sense, the basic idea that all products should be produced as economically as possible in the world is a commonplace. In this particular instance the application of this principle is obvious. Quite unnecessary duplication of capital expenditure, management, etc., would be incurred if the present programmes of the two companies were carried out separately. This can benefit nobody, for it is both to the interest of consumers of nickel, as well as to the stockholders of nickel concerns, that the industry should be conducted with the least possible capital and operating expenditure. I therefore entered, on my return to New York from Canada, into conversations with Mr. Hayden, chairman of the International Nickel Co., having previously had conversations in Canada with large Canadian stockholders in the International Nickel Co., in order to see whether some means could be found to avoid some of the expenditure I have referred to, and to arrive at some form of joint co-operation. I am glad to say that Mr. Hayden is a very progressive man, equally imbued with the same economic thought. Our conversations have thrown considerable light on this problem. I have little doubt that some practical solution will be found which will be highly beneficial to the industry as a whole and to the shareholders who are interested in it."

With regard to the above statement, Mr. D. Owen Evans, a director of the Mond Nickel Co., says that it is all the company can communicate at present. Whatever arrangements may have been arrived at prior to Lord Melchett's departure from New York, the full details could not be communicated by cable.

News from America also indicates that the International Nickel Co. of Canada, Ltd., is to be recapitalised, so as to enable it to acquire the assets of the International Nickel Co. of New Jersey. This move would seem to be in line with some of the earlier reports about the merger.

Steel Research in the United States

VARIOUS metallurgical problems vitally affecting the fundamental principles of the making of steel were considered at the annual meeting of the Metallurgical Advisory Board of the United States Bureau of Mines, Department of Commerce, and the Carnegie Institute of Technology, which was held at the Pittsburgh Experiment Station of the Bureau of Mines on October 19. At these annual meetings, the investigations in the physical chemistry of steel, conducted by the two organisations named, in co-operation with numerous large steel companies, are reviewed, and plans for further investigation are discussed. Suggestions as to the solution of problems studied, or as to other investigations which might be taken up, are invited.

During the past few years there has been a growing realisation among steel plant managers, operators, and metallurgists in the United States that many of the problems arising in the manufacture and use of steel require a more thorough knowledge of the fundamental principles involved in steel-making than is available at the present time. With this thought in mind, the United States Bureau of Mines, in conjunction with the Carnegie Institute of Technology and a Metallurgical Advisory Board composed of members of various steel-producing and consuming companies of the Pittsburgh district, began in 1926 a study of various problems connected with the manufacture of steel. The organisation consists of six members of the staff of the metallurgical section of the Bureau of Mines, two research metallurgists and one analyst, supplied by the Metallurgical Advisory Board, part time members of the Carnegie Institute of Technology staff, and five Research Fellows, taking graduate work at the Institute, three of whom are supplied by the Metallurgical Advisory Board and two by the Institute.

Problems under Consideration

AMONG the problems given consideration at the meeting were the preparation of crucibles which will withstand the severe attack of the various types of slags at high temperatures. It is generally essential that the composition of the slag be held within narrow limits, and that a minimum amount of contamination by the crucible take place. For basic slags, crucibles made of fused magnesia, bonded with hydrochloric acid, have been most successfully used in the United States. For acid slags, silica crucibles are used, but it has been found almost impossible to prevent erosion of the crucible with acid slags high in iron oxide. Graphite crucibles are used whenever a reducing type of slag is being made and when the carbon content of the metal is not required to be low; graphite is also used in making up some of the synthetic slags.

A large part of the investigative program is centred on the properties of slag, this problem being considered the most important single item in iron and steel making. Some of the phases of this problem are the quantity of impurities a slag will absorb from a steel in a given length of time; the rapidity with which iron oxide, which is the agent for the removal of carbon, manganese, phosphorus, silicon and other impurities from the metal, will dissolve in the metal from a given type of slag; and the changes that will occur in other physical properties of the metal with changes in slag composition.

Inclusions in Steel

THE selection of suitable methods for determining oxides in steel is also being given attention. The problem of inclusions in steel is being studied, this being an important matter due to the increased stringency of specifications on various grades of steel and the special qualities demanded in many common grades of steel. The work on inclusions is also being extended to pig iron, and interesting results have been obtained in the relation between uniformity of blast furnace operations and the amount of unreduced oxides in the iron.

At the outset of this investigative program in the fundamental principles of steel making, steel companies in the Pittsburgh district were the main financial contributors. At the end of two years, 29 steel companies are co-operating, and these cover the Chicago, Birmingham, Atlantic Seaboard, and Ohio districts, as well as plants in and near Pittsburgh. The personnel, laboratory space and equipment, and expenditure of money per year have increased approximately 35 per cent., and open-hearth investigations have been conducted in six plants. The co-operation of the operating departments in these plants has been of great value in obtaining important results.

Trade, Commerce, Finance: The Month in Review

From Our Market Correspondent

THERE has been little or no change in the iron and steel trade during the past month; there is certainly no improvement, although one can hardly say that there has been a falling back. The more cheerful tone which manifested itself some weeks ago is still noticeable, but it has not yet resulted in better business. There is at the moment a lull, which in some quarters is considered to be the precursor of a revival in the demand. Such an improvement, if it is to come, ought soon to be starting, because we are now in the eleventh month of the year, and in a surprisingly short time the Christmas holiday season will be upon us, with its inevitable hold-up of business.

It is not very encouraging to think that after all there may be no expansion in trade and that we must continue in the present half-hearted conditions indefinitely, but one needs to be very optimistic to escape that conviction. Indeed, the opinion appears to be gaining ground that it is no use waiting for a revival in trade which as yet shows no signs of realisation, and that success must be won from the trade that is presently available, as financial conditions are becoming too serious to admit of a mere waiting policy.

Mass Production

It is no doubt for this reason that one of the largest steel producing concerns has recently determined to adopt a policy of mass production, to concentrate on the largest possible output, even though, in order to secure a sufficient weight of orders to make this programme feasible, it is necessary to couple with it a price-cutting campaign. What other way is there? The available business is already shared out amongst the various steel makers, and no one works can greatly increase its share except at the expense of the others and only by cutting the prices. That is the wrong method to adopt. The price war is taken up by the other makers, who are not willing to lose their business, and the only persons who get any benefit out of it are the consumers.

Fortunately, such a policy cannot be applied to steel plates and sections, which are subject to the control of the associations, but there is a large volume of trade outside this control, large enough to tempt the makers who are not members of the association as well as those who are, and this class of trade is being subjected to the ravages of a price-war. The effects are to be seen in the prices of such commodities as acid billets and boiler plates. In acid steel billets the downward course of prices has been more rapid than in any other class of steel. The manner in which this trade has been spoiled by the makers themselves is absurd, as well as serious in its consequences.

Price Cutting Evils

When the consumer, who has been paying round about £9 per ton, satisfied with that as the market price and able to maintain his trade on it, suddenly finds that he can buy at less than £8, he must think that either he has been taken advantage of in the first instance, or that the makers do not know their business. The latter would be the correct assumption. There may be some works which can produce more cheaply than the others, but the market as a whole will not long maintain an exorbitant price, and the length of time during which the higher price prevailed was sufficient proof of its reasonableness.

Now, in an attitude of despair, some of the makers have thrown prudence to the winds and ruthlessly slaughtered the price in the false hope of capturing this market. All they have done is to shake the confidence of the buyers, to reduce still further the already short enough list of products on which the steel makers relied to make a profit, and to spoil this trade for themselves and every other maker. It is always easy to reduce prices—any fool can secure orders in that way—but it is extremely difficult to put them up again.

Boiler plates are being dealt with in much the same way. There are certain makers who, apparently, will not be content until they have forced the price down within a short margin of ordinary steel plates; and when they have deprived this product of its legitimate yield, they will no doubt rest satisfied in the knowledge that while they have not increased their own business, they have at least spoiled the trade for the other makers who had built it up on sound lines. Other similar instances could be given, but what is the use!

In the face of such actions, the talk about co-operation amongst the makers seems futile. Their methods of business are too selfish, their conceptions too individualistic to make such a policy successful. "Each for himself and the devil take the hindmost" is the motto of the British steel makers to-day. Some go even further than that: they lose no opportunity which may present itself of hastening the downfall of their competitors.

Rationalisation

Once again the cry is abroad that the only salvation for the industry is rationalisation. There have already been some prominent examples of rationalisation in the steel trade, and they have not proved too successful. The reason seems to be that each individual unit in the combination has been carried on as before, with its own management and executive staff, while an additional administrative staff comes into being to deal with the affairs of the combine. To be effective, rationalisation must mean an amalgamation of firms manufacturing on similar lines, whereby the least efficient of them are closed down altogether, and the work is concentrated in the plants best equipped for turning it out at a profit. The obstacle to this is the selfish spirit to which allusion has been made, and so long as each works can struggle along, there is not likely to be any great development in the way of rationalisation.

The De-rating Scheme

On December 1 there comes into operation the first instalment of the relief provided by the Government's de-rating scheme. The railway companies, by the help of their grant under this scheme, are to reduce the carriage rates on coal, coke, ore and limestone for the steel works. The relief will be very welcome, although it is likely to be small. The original intention was that all this relief should come to the steel works, but already the collieries claim that they are a distressed industry, and therefore they intend to retain the benefit which the reduced rates will confer; in other words, the pit price will be advanced in proportion to the decrease in railway rates. The output control scheme has strengthened their hands considerably, and it is doubtful whether the pig iron and steel makers will be able to resist them.

The new valuations of the works for assessment purposes are proceeding, and generally speaking there seems to be a reduction. The new assessment will be the basis on which the relief under the de-rating scheme will be granted, but it will not come into full effect until the end of next year.

State of the Markets

The pig iron market remains firm, and recent prices have been maintained, with very slight reductions in individual cases to meet special competition. This firmness has had the desired effect of bringing out rather more buying, although this is not of large amount. Whatever improvement there is seems to be confined to the Midlands. The Cleveland makers are finding it difficult to improve their trade in the face of this competition from the Midlands, which not only cuts them out of that market, but actually encroaches on their own district. As a result, the Cleveland trade is dull and outputs are restricted. The hematite trade appears to be a little better and prices are inclined to harden, but the stocks to be cleared are at present a deterrent to any real advance.

The finished steel trade is rather quiet. The official prices remain unchanged, and business in the controlled materials continues on about the same scale as for the past few weeks. In certain districts the shortage of specifications is acute, particularly in South Wales, where the geographical position is a disadvantage. The Scotch makers, too, must be short of work, judging by the efforts they are making to secure trade in the Midlands. In the uncontrolled materials the competition is still fierce. There is less buying of sem-finished and finished steel from the Continent, as the margin in prices has been considerably reduced, and the difference is offset by the uncertainty of delivery and quality.

The output of pig iron in September was 503,900 tons, compared with 519,000 tons in August, there being an increase of one in the number of furnaces in blast. The output of steel was 718,600 tons compared with 648,300 tons in August.

Some Inventions of the Month

By Our Patents Correspondent

***Abstracts of other Patents of metallurgical interest will be found in our Patent Literature published weekly in* THE CHEMICAL AGE.**

Alloys

MATERIALS containing tin, lead, copper, and antimony are worked up by liquating a deep layer in a shaft furnace heated from above so that there is obtained at the bottom, first an alloy consisting mainly of tin and lead. The temperature is then raised to obtain an intermediate alloy which is added to a subsequent charge, and the residue is finally drawn off at a higher temperature. See Patent Application 294,487, bearing the International Convention date, July 21, 1927, by Huttenwerk Niederschönweide Akt.-Ges. of Berlin.

IN Specification 297,165 (Johnson), dated June 30, 1927, a communication from I.G. Farbenindustrie Akt.-Ges. of Frankfort-on-Main, Germany, alloys are described which are highly resistant to the action of chemical reagents, especially hydrochloric acid. They contain at least 78 per cent. of silver and up to about 22 per cent. of a mixture of aluminium, or aluminium and manganese, with one or more of the elements arsenic, bismuth, antimony, magnesium, thallium, tin, zinc, or silicon.

In Specification 297,665 for a Patent of Addition thereto, and of even date therewith, are described similarly resistant alloys containing at least 78 per cent. of silver and up to about 22 per cent. of thallium or of a mixture of thallium with one or more of the elements arsenic, antimony, bismuth, magnesium, tin, zinc, or silicon.

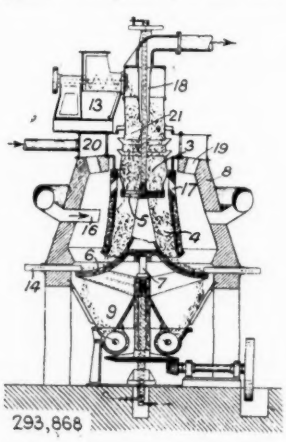
Copper

COPPER is extracted from oxide or oxidised ores by leaching with hydrochloric acid, reducing the resulting solution with sulphur dioxide either during or after the leaching operation, and precipitating the copper as cuprous sulphide from the reduced liquor by sulphuretted hydrogen; the acid liquor, after separation of the cuprous sulphide, is used for a fresh extraction in presence of sulphur dioxide. When the material to be leached is obtained by the roasting of a sulphide ore, part of the sulphur dioxide produced in the roasting may be used in making up the leaching liquor, and a further part may be converted into sulphuretted hydrogen for use in the precipitation. See Specification 296,899, dated September 26, 1927, by F. Dietzsch, of Kingston-on-Thames.

Furnaces

A DISCHARGING arrangement for a cupola furnace is described in Patent Application 294,234, bearing the International Convention date, July 21, 1927, by Freier Grunder Eisen- und-Metallwerke Ges., of Arnsberg, Germany. The slag and metal pass through a single aperture, at the lowest point of the hearth, into an open separator from which they are continuously discharged at different levels. The slag is thus withdrawn from the hottest part of the bath.

METAL (e.g. iron) sponge is produced in the reducing plant shown from briquettes comprising a mixture of crushed ore,



carbon, and a binder. The briquetting machine delivers the charge into a preheating chamber 3 and thence through an adjustable opening 5 into the reducing chamber 4. The latter is heated by the combustion of charcoal and carbon monoxide in the space between the chamber 4 and an outer jacket 8. The carbon monoxide is produced in the chamber 4 by the reduction and passes into the combustion chamber through openings 17. The air for combustion is supplied by tangential pipes 16. The sponge falls on to a rotary table 6 carrying the chambers 3 and 4, and is removed by scrapers 14. See Patent Application 293,868, bearing the International Convention date, July 14, 1927, by H. G. Flodin of Stockholm, Sweden.

Iron

A PROCESS for making iron or steel capable of transformation by working and suitable heat treatment into a working material which is non-sensitive to cold and not subject to brittleness, etc., is described in Patent Application 295,022, bearing the International Convention date August 6, 1927, by Vereinigte Stahlwerke Akt.-Ges. of Dusseldorf, Germany. By choosing a charge of rust-free iron and by highly accelerated melting, the bath is kept as poor in oxygen as possible during the smelting, and the purification is effected in several stages by different purifying media, e.g., by the use of manganese, silicon, and titanium in succession. The smelting and the purification may be carried out in the same basic hearth furnace or in separate furnaces.

IN Patent Application 295,315, bearing the International Convention date August 9, 1927, for a Patent of Addition based on Specification 285,814 (which relates to the working and annealing of steel to make it proof against deformation by cold and ageing), H. J. Van Royen of Hoerde, Westphalia, Germany, describes the production of iron or steel for use in the process of the parent specification by blowing through the molten metal, under a new slag if desired, a reducing non-carburising gas of which the volume does not increase on oxidation. A suitable gas is a mixture of carbon monoxide, carbon dioxide, and nitrogen.

Tin

A PROCESS for recovering tin from cassiterite ores or concentrates is described in Specification 297,784, dated June 24, 1927, by E. A. Ashcroft of Ashburton, Devon. The reduction is effected by divided or powdered iron, aluminium, or magnesium, or by divided or powdered iron—tin, nickel—tin, or nickel—iron—tin alloys. When iron is used, the reduction is effected below 900° C. Instead of iron, a mixture of iron oxides with carbonaceous material such as charcoal or anthracite may be used, in which case, the temperature of the charge is kept below that at which sintering or slag formation occurs.

TIN scrap is detinned by immersion in dilute hydrochloric acid (of the strength obtained by adding to the commercial acid about 3 to 4 times its volume of water) and raising the temperature slowly to 80—90° C. The tin is thus dissolved, leaving most of the iron undissolved. A convenient source of the acid is the waste liquor from the pickling of iron sheets previous to galvanising. The tin is then precipitated from the stannous chloride solution by means of zinc or is deposited electrolytically. See Specification 297,528, dated July 11, 1927, by T. Twynam, of Redcar, Yorks.

Treatment of Sulphide Ores

FRIED. KRUPP GRUSONWERK AKT.-GES., of Magdeburg-Buckau, Germany, in Specification 297,597, dated November 24, 1927, describe an improvement, constituting a Patent of Addition, on the process of Specification 234,826 (see THE CHEMICAL AGE, Vol. XIII, p. 133), for the treatment of sulphide ores or concentrates, applicable more particularly to the manufacture of electrolytic zinc. The sulphidic material is first subjected, preferably in a rotary tubular furnace, to roasting in a purely oxidising atmosphere to remove a portion only of the sulphur. The product, together with reducing agents and sulphur-binding agents, e.g., limestone, adapted to fix the remaining sulphur, is then subjected to a combined reducing, roasting, and distilling treatment to liberate a distillation product. The waste gases containing sulphur dioxide from the preliminary roasting and the distillation product containing metal oxide are then caused to react in the gaseous atmosphere of the preliminary roasting zone or of the volatilisation zone to form metallic sulphates. Zinc sulphate so formed is extracted by lixiviation.

Current Articles Worth Noting

We give below a brief index to current articles in the technical Press dealing with metallurgical subjects.

ALLOYS.—Aluminium alloys. Z. Jeffries. *Metal Ind.* (New York), October, pp. 432–434. Pure aluminium, aluminium casting alloys, aluminium silicon alloys, improvement of mechanical properties by heat treatment, die-cast and permanent mould alloys, etc.

Notes on the manufacture and properties of some copper-cadmium alloys. W. Bannard. *Brass World*, (New York), September, pp. 273–276. A summary of physical properties and methods of alloying.

X-ray analysis of silver-cadmium alloys. A. Astrand and A. Westgren. *Zeitschrift anorganische Chem.*, Vol. 175, Parts 1-3, pp. 90–96 (in German). The alloys are found to be of the same type as the silver-zinc alloys.

ANALYSIS.—Rapid analysis of normal red brass (bronze, brass, etc.) without the application of rapid electrolysis. H. Krug. *Chemiker-Zeitung*, October 27, p. 842 (in German.)

BRASS.—The recrystallisation of α—brass on heat treatment. A. Wittneben. *Zeitschrift Metallkunde*, September, pp. 316–322 (in German).

CORROSION.—Corrosion and metal protection in boiler practice. R. Stumper. *Korrosion und Metallschutz*, October, pp. 217–227 (in German).

Influence of grain size in brass and bronze on the resistance to corrosion. W. Köhler. *Korrosion und Metallschutz*, October, pp. 227–230 (in German.)

Practical research on corrosion. E. H. Schulz. *Stahl und Eisen*, October 4, pp. 1393–1402.

ELECTRODEPOSITION.—Electrodeposition of aluminium. D. B. Keyes, S. Swann, W. Klabunde, and S. T. Schicktanz. *Industrial and Engineering Chemistry*, October 1, pp. 1068–1069. Promising results in the electrodeposition of aluminium on copper have been obtained using ethyl and diethyl aluminium iodide, and mixtures of tetraethyl ammonium bromide and aluminium bromide, as electrolytes.

A new achievement in electro-zincing. *Brass World* (New York), September, pp. 287–288. A drying drum was rotated at a predetermined speed in an electroplating bath of predetermined strength, laying on a predetermined coating of zinc in a specified time.

Chromium plating fundamentals. II. P. E. Edelman. *Brass World* (New York), September, pp. 282–284.

GALVANIZING.—Using gas for hot zincing. I. Ginsberg. *Brass World* (New York), September, pp. 278–280. The economies and improvements effected by the installation of gas fuel instead of coke.

HEAT TREATMENT.—Notes on the relation of design to heat treatment. F. R. Palmer. *Trans. Amer. Soc. Steel Treating*, October, pp. 469–476.

Principles of the heat treatment of steel (By the metallurgical staff of the U.S. Bureau of Standards). *Trans. Amer. Soc. Steel Treating*, October, pp. 502–538.

IRON.—Inclusions in iron: A photomicrographic study. V. General aspects of the inclusion problem. C. R. Wohrman. *Trans. Amer. Soc. Steel Treating*, October, pp. 539–579.

STEEL.—Effect of quenching temperature on the properties of quenched steel. O. W. McMullan. *Trans. Amer. Soc. Steel Treating*, October, pp. 477–501. A comparison of hardness results obtained by different hardness testers is plotted against Vickers hardness as a standard.

Facts and principles concerning steel and heat treatment XXI. H. B. Knowlton. *Trans. Amer. Soc. Steel Treating*, October, pp. 580–608. Discusses various types of heat treating furnaces (continuous, liquid baths, furnaces depending on critical point, special tempering), schemes of quenching, etc. The layout of the heat treatment department is outlined.

X-ray studies of the structure of quenched carbon steel. G. Kurdumoff and E. Kaminsky. *Nature*, September 29, pp. 475–476. Evidence that martensite can be considered as a solid solution of carbon in α—iron.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

Mortgages and Charges

[*NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.*]

BEARDMORE (WILLIAM) AND CO., LTD., London, S.W., steel manufacturers.—Registered September 24, bond and disposition, etc., for £625,000 (including £500,000 outstanding under deed dated July 9, 1924), to Lloyds Bank, Ltd.; charged on works at Parkhead, Dalmuir, Anniesland, Paisley, Old Monkland and Old Kilpatrick; also registered September 24, ex facie absolute disposition, etc., further securing £600,000 already secured by existing bonds, etc., in favour of Lloyds Bank, Ltd., Royal Bank of Scotland, Ltd., and National Bank of Scotland, Ltd.; charged on properties comprised in schedule to the particulars. *£1,520,457. January 5, 1928.

BOHEMIA TIN SYNDICATE, LTD., London, E.C.—Registered October 10, series of debentures for £20,000 (and bonus of 50 per cent.), present issue £4,300; general charge.

FEDERATION TIN MINES, LTD., London, E.C.—Registered September 28, trust deed dated September 17, 1928, securing £22,500 debenture stock; charged on various mineral leases, etc., also general charge.

SHEET BRIDGE COAL AND IRON CO., LTD.—Registered October 10. £300, £250 and £550 debentures, part of £750,000; general charge (except uncalled capital and certain property). *£580,050. October 10, 1927.

Satisfaction

FEDERATION TIN MINES, LTD., London, E.C.—Satisfaction registered September 28, £12,000 registered February 14, 1928.

Aluminium Data

IN pursuance of its policy of disseminating information with regard to aluminium, the British Aluminium Co., Ltd., continues to circulate its handy little booklets. The latest, entitled *Aluminium Data*, contains the latest data in connection with the physical properties of aluminium, and information on various aluminium products, such as: Pipe fittings, bends and sockets; pipe sizes, weights and threads; polishing; presswork; riveting and rivets; rod; sections; sizes and weights of sheets; soldering; spinning; steel cored and stranded aluminium conductors, B.E.S.A. sizes; sizes, weights and safe internal pressures of tubes; welding; sizes of wire, S.W.G.; and much else of use and interest. This booklet is very useful, and may be obtained free on application to the company, at its headquarters, Adelaide House, King William Street, London, E.C.4.

Research as an Insurance

BETWEEN the conception of a new idea and its application to industry there is often a serious lapse of time, and it is one of the tasks of the research worker to prevent this, said Major-General Sir Philip Nash, chairman of the Metropolitan-Vickers Electrical Co., in his presidential address to members of the British Cast Iron Research Association, at their annual general meeting and luncheon at the Hotel Cecil on Wednesday. Sir Philip said he regarded research as an insurance against being taken by surprise. "It enables you," he added, "to get to know of things before the other man springs them on you, and it can prevent the lag between a new idea or new invention in, say, a university laboratory and its commercial application." A third advantage of research was that it tended to elevate the scientific qualification of the staff of a factory or workshop. Mr. H. T. Tizard, secretary of the Department of Scientific and Industrial Research, said that this was the only country in which the taxpayer, as such, found large sums of money for research. Whenever a reasonable proposal was put before the representatives of the taxpayer for expenditure on research it met with real enthusiasm.

Monthly Metallurgical Section

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NOTICE.—Communications relating to editorial matter for our Monthly Metallurgical Section should be addressed to the Editor, THE CHEMICAL AGE, *Bouverie House, 154, Fleet Street, London, E.C.4. Communications relating to advertisements and other business should be addressed to the Manager. Contributions will be welcomed from correspondents on any points of interest to metallurgists bearing on works practice or current research problems.*

The Extraction and Utilisation of Cobalt—(2)

By G. Malcolm Dyson, Ph.D., A.I.C.

In the following, Dr. G. M. Dyson concludes an article, the first part of which appeared in last month's issue of this supplement.

THE hardness of certain of the cobalt steels has brought them into considerable prominence in connection with the manufacture of valves for internal combustion engines, and cobalt-chrome steel valves are now standard on many types of aero-engine. Their advantages lie in the fact that they are not scored by grit, and that they do not scale at 1000° C. For this purpose a moderately high carbon steel (1·1—1·5 per cent.) is used, containing 11–14 per cent. of chromium, 3–5 per cent. of cobalt, and 0·5–1 per cent. of molybdenum. Steels similar to this have been shown to give exceptionally good and permanent cutting edges after heat treatment, and it seems that at the present moment cobalt steel shows considerable potentialities, the fringe of which has only yet been touched.

The non-ferrous alloys of cobalt are, if anything, a little disappointing. They include among them, however, several successful tool metals (often misnamed "tool-steels," since they contain no iron) of the stellite class. The constitution of certain of these is shown in the table below.

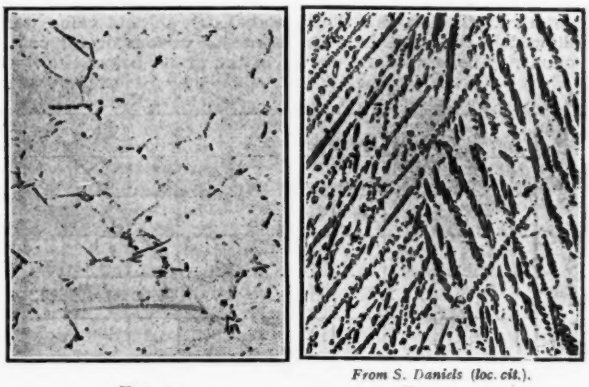
CONSTITUTION OF TOOL STEELS.

Percentage.				Remarks.
Co	Cr	W	Mo	
75	25	—	—	
70	25	5	—	Forges well at a red heat, takes a good cutting edge, and wears well.
60	15	25	—	Lathe tools for steel and cast iron. Will run at a high speed (100 per cent. above that of any true steel).
55	15	25	5	High speed "tool steel." Will run continuously at a dull red heat.
45	15	—	40	Extremely hard, cuts glass and will scratch quartz. The so-called "diamond steel."

The alloying of steel with much cobalt has the effect of increasing very greatly the difficulty with which it worked, and with high-cobalt steel grinding has to be resorted to. The same applies to the non-ferrous metals, and alloys of cobalt and chromium are very difficult to work. The chief alloy of this type, "Cochrome," has to a limited extent replaced nichrome in the construction of heating units. Its advantages are a high working temperature, and greater ability to stand wear, but the high cost of cobalt in comparison with nickel, and the more difficult mechanical properties of cochrome in comparison with nichrome, render it unlikely that the substitution will become a general one.

Lighter Non-Ferrous Alloys of Cobalt

Concerning the lighter non-ferrous alloys of cobalt, there is some divergence of opinion. Guillet states that traces of cobalt are harmful to the strength and working qualities of brass, but others hold that the addition of 1 per cent. of cobalt to brass not only strengthens it but also improves its working qualities. The subject is one upon which further research is needed. Considerable interest attaches to the alloys of aluminium with cobalt, since it appears at first sight that a tough and light alloy might be obtained in this way. The results are, however, somewhat disappointing. The question of cobalt-aluminium alloys was investigated thoroughly by Daniels (*Ind. Eng. Chem.*, **18**, 690 (1926)), who found that the coarsely crystalline nature of cobalt-aluminium alloys increased with the amount of cobalt present. This is illustrated in the micrographs below, in which Fig. 3 shows an example of a section through an ingot of pure aluminium (sand cast) and Fig. 4 a section through a bar of aluminium cobalt alloy containing about 10 per cent. of cobalt. Both are magnified about 100 times, and in the second section the eutectic Co_3Al_{13} is plainly visible in linear arrangement. The



From S. Daniels (loc. cit.).

FIG. 3. FIG. 4.

SECTIONS OF PURE ALUMINIUM AND AN ALUMINIUM COBALT ALLOY.

aluminium ingot shows a trace of aluminium silicide. In addition, the presence of more than 1 per cent. of cobalt in aluminium increases the solidification shrinkage greatly.

Cobalt Compounds

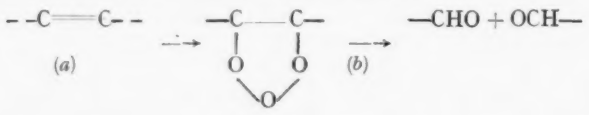
Cobalt compounds are associated in the chemist's mind with two great industries, ceramics and the manufacture of varnishes, and apart from a small amount of cobalt salts used in catalytic processes, nearly all the cobalt compounds of commerce are ultimately destined for these two industries. In the varnish industry various salts of cobalt (the acetate, oleate, borate, linoleate, tungstate, and oleo-resinate) are added in small proportion to the varnish in order to hasten the absorption of oxygen and the formation of the dry film.

The acetate is most widely used in conjunction with linseed oil, between 0·2 and 0·4 per cent. being used. The advantage of the use of such compounds lies in the great shortening of time in which the drying takes place, in the absence of discolouration which inevitably sets in when oil dries in the absence of a catalyst, and in the fact that cheap oils such as soya oil and fish oils can be incorporated into varnish. The preparation of cobalt salts for use in varnish calls for little comment save in the case of the resinates, in which two alternative methods are available. To prepare cobalt resinate the resin may be melted at 75–85° C., raised to 140° C., and the requisite amount of cobalt hydrate added. Solution takes place readily as the temperature is raised to 170–180° C., after which the product is allowed to cool. It is 99·9 per cent. soluble in vehicle oils, whereas that from the "wet" process contains about 2 per cent. of difficulty soluble matter. The "wet" process consists in dissolving the resin (which should have m.p. 75–85° C.; sap. value, 170–180) in caustic soda solution and salting out the sodium salt with sodium chloride. The sodium resinate is dissolved in water and treated with a solution of a cobalt salt, when cobalt resinate is precipitated

and may be filtered off, washed and dried. The relative efficiency of the two forms may be judged from the following data :—

Vehicle.	Drier.	Time Taken to Dry Film (in Hours.)
Linseed oil heated to 130° C. ..	None	72
Linseed oil heated to 130° C. ..	2% Cobalt Resinate (Precip.)	8
Linseed oil heated to 130° C. ..	2% Cobalt Resinate (Fused)	14

The mechanism underlying the action of the drier is somewhat obscure, in spite of the fact that it has formed the subject of much research work. It appears that the cobalt compound acts in a catalytic capacity by stimulating the formation of peroxides at the unsaturated linkages of the oil (*a*), giving a



compound containing the group (*b*). This, then, gives an aldehydic compound and finally an acid, thus completing the oxidation. To test this theory the change of acid value was followed in the presence and absence of various drying compounds. The results are shown in the graph below (Fig. 5).

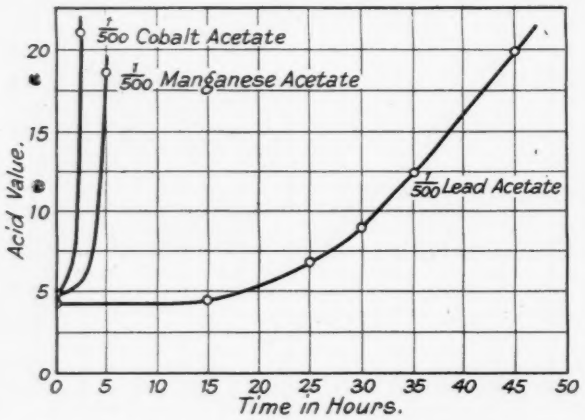


Fig. 5.—Change of Acid Value of Linseed Oil in the Presence of Various Drying Compounds.

With lead acetate, the oxidation (as judged by increase in acid value) proceeds quite slowly, but in the presence of manganese acetate, and even more so with cobalt acetate, a very rapid acceleration in the rate of increase of acid value is noticed.

Use in Ceramics

In the ceramic art, cobalt has been used since the Middle Ages for the production of blue colours. It may be used as a body stain, as a glaze stain, or in the form of under or on glaze colours, the method of application varying with the nature of the work and the purpose to be effected. As a body stain it is extensively used to correct the yellow or slightly orange tint due to the presence of iron in the clay. The amount used is approximately 1 lb. of cobalt oxide to each ton of clay. The oxide is finely ground with China Clay and water, and the wet mixture screened from particles and added to the main batch. The disadvantage of this method is the unevenness produced by faulty mixing in of the oxide, in view of which cobalt chloride is often used in place of the oxide. It might be thought, at first sight, that the cobalt would be lost to a large extent during the pressing of the clay. This is not the case, since the cobalt is retained by the absorptive capacity of the China Clay, and the wash water from the filter presses contains only about half the cobalt used. The well-known Wedgwood tint is an example of body staining with cobalt oxide, barium compounds being used in addition to modify the tint.

In glaze stains, the cobalt is added as the oxide to a high lead glaze, producing in this way a Royal Blue which can be modified by thinning or the addition of yellow to almost any shade ; whilst for on and under glaze colouring a cobalt silicate is used. This is especially prepared for the purpose, and many formulæ exist for the production of various shades. The well-known " Mazarine Blue," is obtained by melting together in an earthenware pot cobalt oxide (40 parts), pegmatite (11 parts), flint (25 parts) and whiting (4 parts). This is ground and applied in the usual way.

Coldworking of Iron

Scholarships for Research at Sheffield

The announcement has just been made of a benefaction to the University of Sheffield on the part of the Ironmongers' Company of London. At a dinner of the Company held recently, the Master (Mr. Ernest A. Ebblewhite), in replying to the toast of the Company, proposed by the Master Cutler (Mr. T. G. Sorby), stated that it had been decided to found an Ironmongers' Company Research Fellowship and two Ironmongers' Company Research Scholarships for the study of the cold-working of metals, for which purpose a grant of £800 per annum for seven years was to be made to the University.

It is hoped that the necessary plant for carrying out the work will be provided by the generosity of the manufacturers through the Cutlers' Company of Hallamshire. Mr. Percy Lee, the ex-Master Cutler, has interested himself for some months past in the problem of coldworking, and is largely responsible, together with Mr. Ebblewhite, for the scheme submitted to the Ironmongers' Company by the University, as a result of which that Company has come to its generous decision. The branch of industry which the research contemplated is intended to serve has grown rapidly in importance in recent years, and coldworked material, whether in the form of wire, strip, sheet or other products, is becoming increasingly useful. Certain applications, such as those of the aircraft industry, call for the very highest qualities in such coldworked material. The research work necessary to obtain such qualities has mostly been carried out by the manufacturing firms, although certain investigations of importance have been made in universities in this country. A point has now been reached at which the producers of the material find that problems arise which cannot be solved without provision for systematic research by trained investigators. It is intended, therefore, to establish and equip a laboratory in the applied science department of the University, with the necessary plant for drawing and rolling steels and with all the apparatus which will be required for a systematic study of the metallurgical changes which are involved in the processes and of the engineering conditions which will give the most favourable results.

Incidentally the experience gained by research workers in such a laboratory will make them particularly valuable to the industry when they pass out to positions in the works, as it is hoped they will do. The scheme has the fullest support of the industry, and it is believed that this co-operation between producers and investigators will have the most beneficial effects.

South African Steel Agreement

The negotiations which were commenced in South Africa between the United Steel Corporation and the South African Iron and Steel Industrial Corporation have now resulted in an agreement being reached between the two companies. The announcement is made by Dr. H. J. van der Bijl and Mr. C. F. Delfos, of the South African Iron and Steel Corporation, and Major Aubrey Butler and Mr. Theodore Marks, of the Union Steel Corporation. Under this arrangement the two companies will each manufacture certain lines of steel, and will not in any way compete with each other. The agreement further provides for absolute mutual co-operation between the two concerns, so that not only will competition be eliminated, but the companies will generally work together in the development of the iron and steel industry in South Africa.

Metallurgical Topics: Monthly Notes and Comments

From Our Own Correspondents

Cadmium and its Uses

THE paper on cadmium read last week by Mr. C. F. Moore, before the Junior Institution of Engineers, was none the less interesting and valuable from the fact that the author limited the treatment of his subject to broad general lines, for, after all, cadmium is a metal which is in comparatively limited use, and respecting which many problems arise which most text books fail to elucidate. Its employment as a cadmium-lead alloy for the sheathing of electrical cables, which Mr. Moore touched upon, is one which has much to commend it, and in regard to which little published information is forthcoming. Copper-cadmium (1 per cent. Cd) is likewise said to be far more durable for trolley wire than best hard-drawn copper wire. In regard to cadmium plating, Mr. Moore had some sound, if disillusioning, remarks to make. Finally, he made a cryptic reference to the difficulty which arises in eliciting the desired information really needed by those who use cadmium, or who would like to do so if they could get any to use.

The Remelting of Cadmium Scrap

THE remelting of cadmium scrap requires certain careful precautions unless very heavy losses are to be experienced by the volatilisation of what is an expensive metal. For instance, it is difficult at times to prevent oxidation of the melt, which at the temperature of molten cadmium is exceedingly rapid and extensive. Mr. Moore's paper contains a hint that economy can be attained by melting the scrap under a layer of heavy oil in a cast iron kettle. Fused borax is sometimes used for the same purpose, but does not give satisfactory results. On the other hand, a recent writer has recommended the addition of a pound or two of caustic soda to the melting pot. The bars are not covered with caustic, but melt on the bottom and slide into the fused alkali without much oxidation. The molten mass under the caustic is dipped out with a specially shaped ladle, designed to hold back the molten caustic. It is, of course, necessary to avoid getting the caustic trapped in the metal, but with due precautions any residual caustic will float at the top of the melt. Reverting to the secrecy which shrouds metallurgical operations in which cadmium is involved, it should be noted that at the moment there is not sufficient cadmium made to supply indefinitely all requirements, while the supplies of such metal as is available are very closely controlled. The policy, in these circumstances, is to dole out to a limited number of customers the cadmium they require, and to supply them with the requisite metallurgical details, but to discourage the use of cadmium in unskilled hands. There is something to be said in favour of this policy, for it would be easy to bring the metal into disrepute, and, therefore, in the long run, to discourage its use, although it may be said that, at the same time, this policy has the effect of unduly limiting the employment of cadmium.

Iron and Silicon in the Planetary Spaces

ONE of our universities is about to be endowed with a Chair of Astrophysics. The mundane sources of metals are not inexhaustive, although alarmists tell us that tin is being used up at a great rate, and some years ago it was predicted that an iron-ore famine would occur in about 100 years' time. Iron, in small amounts, is one of those metals which can be recruited from the skies, and a Russian expedition is busy hunting for a colossal meteorite which fell somewhere in Siberia a few years ago. The meteorite has apparently, to judge from the latest reports, dug itself in, but its whereabouts have been discovered. There is a school of thought that believes that all our iron has been derived from extra-terrestrial sources, and that it has been obtained from planetary bodies which have been shattered and are, indeed, still being shattered. There is, similarly, a school of thought that envisages a universe in which not only matter but energy, between which it is becoming increasingly difficult to discriminate, is constantly running down. The end will, apparently, be helium and stagnation, or perhaps hydrogen and worse. However, Professor Millikan, the distinguished American physicist, has some reassuring news for us. We may, he says, abandon our dreams of developing untold energy by the homely process of disintegrating atoms; there are more abundant stores perennially replenished in the inter-planetary spaces, by the process of building up atoms. The atoms mostly made in these circumstances are iron and silicon. It may be expected that after the science of astrophysics has developed still further, a syndicate, or at least a holding company of some kind, will be established to tap and profitably divert, if only to themselves, these future resources of iron, silicon, and energy!

Strain Markings in Steel

THE interest aroused by the paper read some three years ago on the detection of strain in mild steel, by T. H. Turner and J. D. Jevons, before the Iron and Steel Institute, will be stimulated by the work published in Research Paper No. 15, of the Bureau of Standards, and carried out by Dr. Rawdon himself. It affords a good deal of suggestive insight into the plastic behaviour of this material, and the results are paralleled in some experiments of the same kind carried out with aluminium. The first appearance of strain markings on polished specimens of steel of average boiler-plate composition, but specially low in phosphorus, stressed in an Amsler machine, coincided with the yielding of the metal, and could, in fact, be identified very closely with the proportional limit. On loading several times in succession, the strain markings are propagated as continuations and extensions of those which had already appeared, until the entire reduced section of the bar has been affected, and no increase in the elastic properties by overstrain can occur until this has been accomplished. It was found that observations on polished specimens serve admirably to demonstrate the progressive character of the yielding of a metal under tensile stress, and to show how far accommodation has proceeded. In conjunction with the plastic contour work with which Professor Dalby's name is so closely associated, and which formed the subject of his recent lecture before the London Section of the Institute of Metals, such investigations are calculated to throw much useful light on how plastic metals behave under stress, and will also undoubtedly serve, eventually, as methods for the actual determination of stress-strain phenomena.

Pure Iron Uses

ALTHOUGH village crafts are a thing of the past, there is a notable movement afoot, encouraged by certain art-craft associations and provincial promoters, which bids fair to resuscitate one, at least, of them, and should be attended with some measure of success. This is the craft of the blacksmith, directed more especially to making small iron and steel work, tools, etc., and in particular to a renaissance of wrought iron ornamental work, such as gates, railings and similar craft work. The village forge does far less shoeing and tyre-making than it used to before the advent of the motor car, the lorry and the steam plough, and although the town smith still finds work in connection with the newer modes in vogue, his village confrère is seeking fresh outlets for his skill. Wrought iron is, of course, the easiest medium for him to work in, and if the new activity finds sufficient encouragement it should help to revive yet another of our depressed industries. Wrought iron is fairly durable, but the ideal material for the smith, once he had mastered its little eccentricities, would, of course, be pure iron, which is to be preferred for many reasons besides its superior durability. It is making great headway in other directions as well, as its surface finish is better than wrought iron, and thus more suitable as a base for enamelled hardware, and for galvanised and tinned ware. The latest book on enamels, by L. R. Mernagh (Charles Griffin and Co., Ltd., 18s. net), testifies to the excellence of "Armco" ingot iron as a base for enamelled work, which he further describes as having good drawing qualities and being absolutely regular in action. He recommends it specially for sign plate manufacture.

Trade, Commerce, Finance: The Month in Review

From Our Market Correspondent

THERE has been no development in the iron and steel trade for the past month which calls for special notice. The dispute in the German steel industry still continues, and the British steel makers are reaping a temporary advantage from that stoppage, although it does not amount to very much. The French and Belgian makers seem to be the chief gainers, and they are losing no time in taking over the markets which for the time being are cut off from German supplies. Offers of semi-finished steel are still being freely made to this country, but they are not attractive. So far as this country is concerned, the labour trouble in Germany is a mere incident, and has had surprisingly little effect on conditions here. Our troubles are too deep-seated for an event of that kind to make any great impression. We must put our own house in order before we can hope to be in a position to take full advantage of such external influences.

No Safeguarding at Present

Generally speaking, the present month has seen merely a continuance of the conditions which prevailed during the preceding month. The industry appears to have settled down into a course which must now be considered a normal one. Subject to slight ups and downs, this is the course which the steel trade will have to follow until something abnormal intervenes to change it. His Majesty's Government are still very plainly stating that that change is not to be expected by the way of safeguarding. The Marquis of Salisbury, speaking for the Government in the House of Lords recently, made a definite statement that safeguarding could not be granted at present.

At the same time there is no doubt that the Government is seriously concerned about the condition of the steel trade, and it would welcome any suggestion which would relieve the situation without committing the Government to an open policy which might jeopardise its chances at the polls. It is exploring every avenue in the hope of finding a way out of the trouble.

Reorganisation

Sooner or later it will be realised that there is no really effective remedy short of a drastic reorganisation of the industry as a whole. Any scheme which stops short of that is a mere palliative, and while it may afford temporary relief, it will certainly not restore prosperity to the industry. Even safeguarding, if it were granted, would be a doubtful success unless it led up to the greater undertaking. In this respect there is a similarity between the cotton trade and the steel trade. It is common knowledge in Lancashire that there is urgent need for the expenditure of a huge sum of money to put the cotton mills into efficient working order; and were it possible for this to be done, the resulting orders would be sufficient to give a very considerable impetus to the steel trade. But it cannot be done. After such a long period of depression the money simply is not there and the state of trade does not hold out any hope of providing the means.

So it is with the steel trade. It is essential that there should be a complete overhauling of the existing plants, a ruthless scrapping of all that is out of date and the installation of the most modern methods of production. And not only must there be a revision of the technical processes, but also a modernisation of the administrative and distributive operations. Then, and not until then, will the steel trade of this country be able to regain its proud place and hold its own with any and all of the competing countries.

Position in Germany

Germany is already in that fortunate position. The shrewd leaders of the industry there took full advantage of the inflation period by putting all available money into new plant, with the result that when the deflation came they could face it in the knowledge that while they had little or no money, they had most efficient plant, by which the money could be made; and that they needed only to tide over a comparatively short period, after which they could go ahead and regain their old prosperity. The German steel works as a whole are now the finest and most modern in the world, and Germany has again taken her place as second in the list of the steel-producing countries, notwithstanding the disabilities which were imposed on her by the Peace Treaty.

What, on the other hand, is the condition of our steel works? In the war period, extensions were made to most of the existing works, but this was done with the sole object of increasing the supply of munitions and not from the point of view of the reorganisation of the industry. Many of these additions are now out of date, and instead of a reconstructed industry we have, with one or two exceptions, merely a series of patched-up plants which lack the modern equipment to enable them to produce economically; and each one of these is struggling to keep going in competition with every other steel works in the country. Now, after a period of eight years since the boom of 1920, we are left with an impoverished industry, mostly in the hands of the banks, without the means to put itself right. Many millions of money are wanted to achieve this object, and it will have to be found unless we wish to see the industry gradually slip back into chaos. It is because of this that even if safeguarding comes it must be looked upon as a preliminary to the wider scheme of reconstruction.

Financial Questions

The financial reorganisations which are now going on hardly touch the fringe of the problem; they merely postpone the evil day. There was a significant note in one of the papers recently regarding the reconstruction of Baldwins. It was pointed out that the interest on loans under the new scheme is over £60,000 a year, which is more than double what it was previously! Consider again the recently published reports of Pearson and Knowles and the Partington Co. They are still making losses notwithstanding the reorganisation. Must it be repeated that no amount of capital reorganisation will save the industry or the particular works which have to submit to it? The root of the trouble must be attacked, and nothing short of a thorough reconstruction of the whole industry along the lines of the most modern developments will save it from disaster. The steel makers, the shareholders, and the banks will all have to take their share and face the losses which cannot be avoided.

The Government scheme of relief in railway rates for the steel trade had now taken more definite shape, and the Ministry of transport has issued a pamphlet describing the working of the scheme and giving particulars of the reductions in rates. On the face of it the scheme should mean a considerable saving to the steel works. One source of trouble in the scheme is that the relief will be given in the first instance to the party who pays the carriage charges. Some of the coal owners have already notified their intention to take advantage of this provision by retaining the relief on coal and coke. They have no right to do so, as the relief was clearly intended for the steel works, and it is to be hoped that the steel makers will take concerted action in resisting this high-handed procedure.

State of Markets

The pig iron market has undergone little change since last month. The makers have been able to maintain their prices, and some of them have very good order books. The demand remains fairly good in all districts. Cleveland reports an increasing demand for both foundry and engineering industries. Sales are in excess of output, and there are considerable withdrawals from stock. The export demand does not improve. Costs are increasing slightly owing to the gradual advance in the price of coke.

There is a fair amount of business passing in semi-finished steel. The German labour trouble has been of assistance in this respect, and consumers are turning more to the home producers, as there is not much difference in price, and the better delivery is a great inducement. The finished steel trade shows no expansion. The official prices for plates and sections remain unchanged, although if the advance in the price of coal and coke continues, it is possible there will have to be an increase in steel prices. In the uncontrolled material the competition continues unabated.

The production of pig iron in October was 543,600 tons, compared with 503,900 in September, with an increase of 5 in the number of furnaces at work. The output of steel was 756,000 tons, compared with 718,600 in September.

Some Inventions of the Month
By Our Patents Correspondent

Abstracts of other Patents of metallurgical interest will be found in our Patent Literature, published weekly in THE CHEMICAL AGE.

Alloys

F. KRUPP AKT.-GES., of Essen, Germany, in Patent Application 297,420, bearing the International Convention date September 21, 1927, describe steel alloys containing 9—17 per cent. of manganese, 0·8—1·7 per cent. of carbon, and up to 5 per cent. of aluminium, with or without the addition of one or more of the metals nickel, chromium, tungsten, molybdenum or vanadium. The products may be heated to 1000° C. and cooled quickly.

AN alloy especially resistant to corrosion by hydrochloric acid contains at least 78 per cent. of silver and up to about 22 per cent. of a mixture of either (1) manganese with one or more of the elements thallium, magnesium, zinc, arsenic, antimony, bismuth, or tin ; or (2) manganese, thallium, and silicon with one or more of the above-named elements. See Specification 298,122 (Johnson), dated June 30, 1927, a communication from I.G. Farbenindustrie Akt.-Ges., of Frankfort-on-Main, Germany, constituting a Patent of Addition based on Specification 297,165. (See THE CHEMICAL AGE, Vol. XIX, p. 39 [Metallurgical Section].)

Aluminium

A PROCESS for the electrolytic production of pure aluminium in dense form from the crude metal or its alloys, using the material to be refined as a solid anode, with a solid cathode and an electrolyte which consists of halides of aluminium and of alkali or alkaline earth metals, and which has a lower fusion point than have the electrodes, is characterised by the addition to the electrolyte of small quantities (0·1 to 0·5 per cent.) of manganese, lead, cadmium, nickel or compounds or salts thereof. The addition may be made by alloying the added metal with the anode metal. See Specification 299,689 (Wade), a communication from Aluminium-Industrie Akt.-Ges. of Neuhausen, Switzerland, dated October 25, 1927.

Chromium Plating

CHROMIUM is deposited (1) from an electrolyte consisting of chromic acid with a small addition of an oxide or salt, e.g., sulphate, of aluminium or magnesium, the total free and combined sulphuric acid not exceeding 1·5 per cent. of the chromic anhydride present ; (2) from a bath consisting mainly of chromic acid with addition of a calculated quantity of barium hydroxide or carbonate to remove excess of sulphuric acid. See Patent Applications (1) 296,988, (2) 296,989, bearing the International Convention date September 10, 1927, by W. G. Poetzsch, of Leipzig, Germany.

Detinning Scrap Iron

A. DOSSMANN, of Genoa, Italy, describes in Specification 298,103, dated June 29, 1927, a process for the treatment of tinned scrap iron for the removal of the zinc, lead, tin, and varnishes, and the conversion of the residual scrap into briquettes. The zinc, tin, and varnishes, and most of the lead, are first removed by a preliminary cleaning, e.g., by pickling in acid or by electro-chemical treatment. Insoluble lead compounds adhering to the cleaned scrap are then removed, e.g., by treatment with a hot caustic soda solution containing a soluble carbohydrate material such as molasses. The residual scrap is compressed into briquettes of such a density that the penetration of the heating gas during the subsequent heating, which welds the briquettes into billets, is reduced to a minimum so as to avoid oxidation. Small quantities of substances adapted to neutralise the oxidising effect and/or to reduce the oxides formed (e.g., oils, lampblack, naphthalene, coal, coke, lime, limestone, fluorspar, colophony, boric acid, or ammonium salts) may be added before or after briquetting.

Flotation Processes

IN the foam-flotation treatment of coal and ores it is necessary to provide flotation agents having the property, on the one hand, of wetting effectually the material to be floated, and, on the other, of producing a foam. According to Specification 298,736 (Johnson), a communication from I.G. Farbenindustrie Akt.-Ges. of Frankfort-on-Main, Germany, dated August 19, 1927, such agents are obtained by oxidising soft or solid hydrocarbons such as paraffin waxes or montan wax at temperatures not exceeding 200° C., so that substantially no decomposition to products containing fewer carbon atoms in the molecule occurs. In some cases it is desirable to neutralise acidity in the products, preferably with ammonia.

Iron

CHLORINATION processes for extracting iron from its ores as ferric chloride for subsequent reduction, e.g., by hydrogen, are described in Patent Applications 297,096—7, bearing the International Convention date September 16, 1927, by Vereinigte Stahlwerke Akt.-Ges., of Dusseldorf, Germany. According to Specification 297,096, the ore is treated with chlorine or gaseous hydrochloric acid under a pressure of about 10 atmospheres. The speed of the reaction is stated to be increased by altering the pressure from time to time. According to Specification 297,097, the chlorinating agents used are such as are adapted for a cyclic process. Thus, ammonium chloride with or without chlorine, gaseous hydrochloric acid, or magnesium chloride, may be used, the ferric chloride produced being freed from other chlorides by fractional distillation. The hydrogen chloride produced in the reduction of the ferric chloride is combined with ammonia resulting from the chlornation, thus regenerating ammonium chloride for use again.

Iron Alloys

AN iron alloy, adapted to be cold-drawn into wire of high tenacity specially suitable for armouring submarine cables, contains copper and silicon in substantially equal proportions, their combined content not exceeding 15 per cent. · Preferred alloys contain 3 to 6 per cent. of copper and 3 to 6 per cent. of silicon, with or without the addition of a small quantity (0·3 to 0.5 per cent.) of a deoxidiser such as manganese. See Specification 299,502, dated July 27, 1927, by W. S. Smith, of Newton Poppleford, Devon, H. J. Garnett, of Sevenoaks, Kent, and J. A. Holden, of Gidea Park, Essex.

Lead

IN the Specification 298,684, dated April 5, 1927, of a Patent of Addition based on 264,569 (see THE CHEMICAL AGE, Vol. XVI, p. 23 [Metallurgical Section]), S. C. Smith, of London, describes a method and apparatus for use in carrying out the process of the parent specification. The chloridising, washing, and/or leaching treatments are performed upon filtering means, consisting of or protected by perforate rubber material or woven rubber cord fabric adapted to resist corrosion and erosion and capable of standing up to movement or agitation of the magma upon it. The procedure and some preferred constructions of the filter drums used are described and illustrated in detail.

Platinum

A PROCESS for removing the iron and nickel from norite and like ferruginous sulphide ores containing platinum and other precious metals is described in Specification 296,744, dated June 7, 1927, by S. C. Smith of London. The sulphide matte, which remains after removal of the silica, is leached in the finely-divided unroasted condition with an acid, preferably sulphuric. The leached matte is then roasted and subjected to a further leaching with acid to remove the copper. The sulphuretted hydrogen produced in the leaching of the sulphide matte is recovered and used either to precipitate the copper contained in the liquor from the second leaching or for making sulphuric acid for the leaching operations.

Roasting Furnaces

To prevent sintering of sulphur-containing materials, during roasting in a rotary tubular furnace, provision is made for cooling that part of the furnace where the most heat is generated. Thus excess of cool air may be introduced, water or other liquid may be injected, the furnace wall may be made of a thickness ensuring increased loss of heat by radiation, or pipes conveying cooling air may be arranged within the furnace or its lining. See Patent Application 297,419, bearing the International Convention date September 21, 1927, by F. Krupp Grusonwerk Akt.-Ges., of Buckau, Magdeburg, Germany.

Current Articles Worth Noting

We give below a brief index to current articles in the technical Press dealing with metallurgical subjects.

ALLOYS.—The gold alloy 750/2. Its behaviour on cold-working and annealing. W. Heike and F. Westerholt. *Zeitschrift anorganische Chem.*, Vol. 176, Parts 1–3, pp. 200–204 (in German). Deals with the alloy gold 75 per cent., silver 4 per cent., and copper 21 per cent.

ANALYSIS.—The delicacy of the detection of small quantities of impurities in cadmium and copper. G. Tammann, A. Heinzel and F. Laass. *Zeitschrift anorganische Chem.*, Vol. 176, Parts 1–3, pp. 143–146 (in German).

The delicacy of the detection of small quantities of impurities in iron. G. Tammann and W. Salze. *Zeitschrift anorganische Chem.*, Vol. 176, Parts 1–3, pp. 152–154 (in German).

COPPER.—The present position of the metallurgy of copper. M. Fourtment. *Revue de Metallurgie*, September 9, pp. 481–495 (in French).

CORROSION.—The relative corrosion of electro- and hot-galvanised steel. W. S. Patterson. *J.S.C.I.*, November 2, pp. 313–317 T. Under some conditions of exposure the hot-galvanised coating is the more resistant to corrosion, while under others there appears to be little to choose between the merits of the two types of coatings.

The theory of metallic corrosion in the light of quantitative measurements.—II. G. Bengough, J. M. Stuart and A. R. Lee. *Proc. Roy. Soc. A.*, November 1, pp. 88–121.

A note on the corrosive action of sulphur monochloride. E. H. Harvey. *Chem. Met. Eng.*, November, p. 684. In the case of copper and tin, coatings are formed which protect the metal beneath.

ELECTRODEPOSITION.—The causes and prevention of pitting in electrodeposited nickel. D. J. Macnaughtan and A. W. Hothersall. *Trans. Faraday Soc.*, October, pp. 497–509.

GENERAL.—Tungsten carbide: A new tool material. S. L. Hoyt. *Trans. Amer. Soc. Steel Treating*, November, pp. 695–718. Tungsten carbide in tool form has a Brinell number of over 2,000 with half the strength of high speed steel, and is capable of scratching sapphire. Tests on machining various substances are described. On cast iron and steel the carbide tools are said to be greatly superior to high speed steels, and capable of sustaining cutting at speeds which are several times that commonly used. The paper is claimed to give an account of the first marked improvement in cutting tools since the introduction of high speed steels by Taylor and White.

An electrochemical process for the separation of gold and silver. F. Vogel. *Die Metallbörse*, November 17, pp. 2553–2555; November 24, pp. 2609–2611.

RUSTING.—The "colloid" theory of the rusting process. G. Schikorr. *Corrosion and Metallschutz*, November, pp. 242–245 (in German).

The rusting apparatus. V. Duffek. *Korrosion und Metallschutz*, November, pp. 251–258 (in German). Describes an instrument which may be used in corrosion tests.

STEEL.—Some practical aspects of the nitriding process. H. W. McQuaid and W. J. Ketcham. *Trans. Amer. Soc. Steel Treating*, November, pp. 719–743. For general nitriding purposes, 1200° F. is recommended; at 950° C. a harder but much shallower case is obtained. The field for nitriding seems to lie in applications where low unit pressure prevails, and where warpage and resistance to corrosion are important factors.

Principles of the heat treatment of steel.—II. By the metallurgical staff of the U.S. Bureau of Standards. *Trans. Amer. Soc. Steel Treating*, November, pp. 744–766. Deals with quenching (rate of cooling for hardening, martensite and troostite, the mass effect, quenching media, temperature of cooling bath, nature of martensite, expansion and contraction of steel, cracking of quenched steel, and localised hardening); and tempering (instability of martensite, secondary troostite, temper colours, sorbite, coalesced sorbite, dependence of properties on structure, tempering media, self tempering, and untempered steel).

WELDING.—Electric welding joins the field in high pressure equipment. N. W. Krase. *Chem. and Met. Eng.*, November, pp. 661–664. The construction of electrically-welded vessels for pressures as high as 1,000 pounds or more, at the plant of the A. O. Smith Corporation (in the United States), is described.

A Bibliography of Corrosion

DR. W. H. J. VERNON, well-known for his investigations on corrosion, has placed all those who are concerned in any way with the subject under a great debt to him, by the compilation of *A Bibliography of Metallic Corrosion* (Edward Arnold and Co., pp. 341, 21s.). The bibliography comprises some 3,800 entries, classified under four headings, as follows: General; The Corroding Medium; The Metal; and Methods of Protection. Individual headings are in alphabetical order, and cross-referenced where required. This book is much more than a compilation; it is the work of a scientific investigator of high standing who has carried out important experimental work on the subject. Under each heading the information contained in the reference is tersely given where necessary. For example, under the heading "Biological influences," the following entry occurs: "Ellis, S. H.—Corrosion of the steel wharves at Kowloon, Hong Kong. *Proc. Inst. Civ. Eng.*, 199, **1914**, 133. Marine growth attached to steel piles gave rise to serious corrosion; large pits full of sulphide of iron." It will be readily appreciated that by such means an enormous amount of valuable information may be imparted. Wherever possible, the author refers not only to original papers, but to published abstracts. The aim has been to include all work published up to the end of 1927. As Professor H. C. H. Carpenter says in the introduction: "The book is entitled *A Bibliography of Metallic Corrosion*. From the title it might be anticipated that it is in the nature of a catalogue. It is, however, far more than this, and an alternative title which would, in my opinion, explain its scope more adequately and certainly with more justice to the labours of the author, would be 'A Dictionary of Metallic Corrosion.'" Its value to all engaged in the study of corrosion cannot be overestimated; and in addition it should find a place on the bookshelf of every industrial chemist and many engineers.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

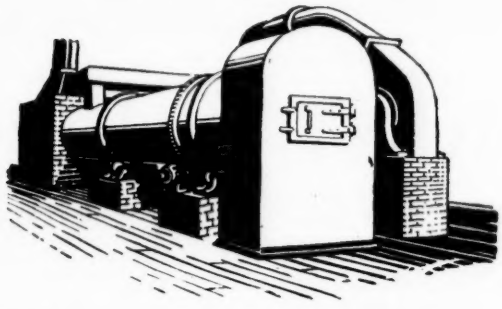
Mortgages and Charges

[*NOTE.—The Companies Consolidation Act of* 1908 *provides that every Mortgage or Charge, as described therein, shall be registered within* 21 *days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case, the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.*]

PEARSON AND KNOWLES COAL AND IRON CO., LTD., Warrington.—Registered October 30, £25,000 charge, to Sir W. G. Armstrong Whitworth and Co., Ltd., Newcastle-on-Tyne; charged on company's lands, works and fixed and other assets. *£1,820,000. October 13, 1927.

Satisfaction

WALKER (HENRY) AND SON, LTD., Newcastle-on-Tyne, ironfounders.—Satisfactions registered October 29, all moneys registered August 26, 1927, and £9,000, part of amount outstanding July 1, 1908.



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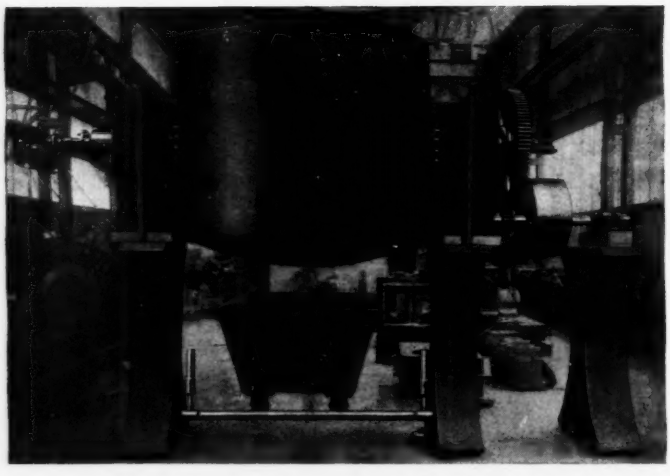

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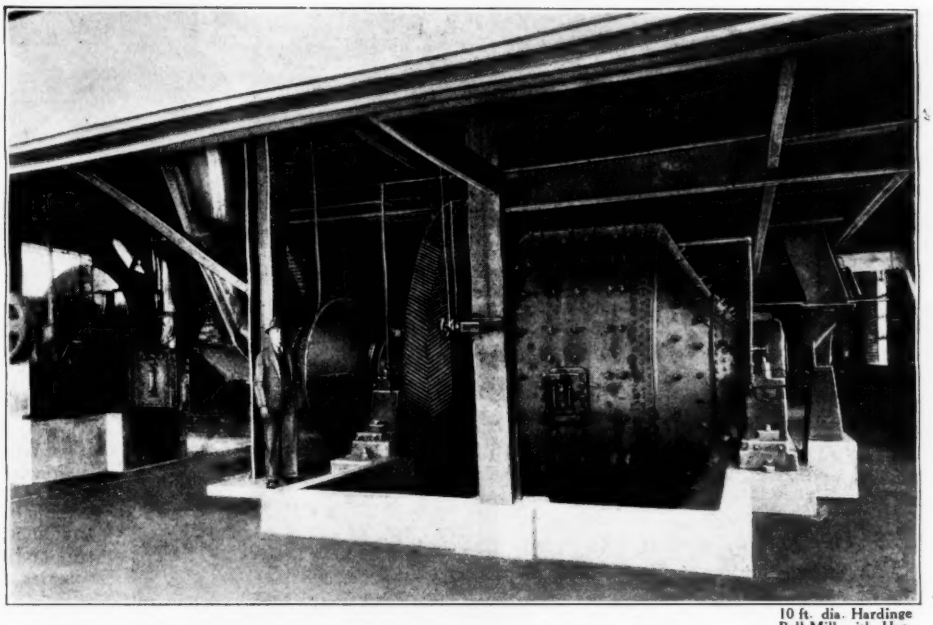

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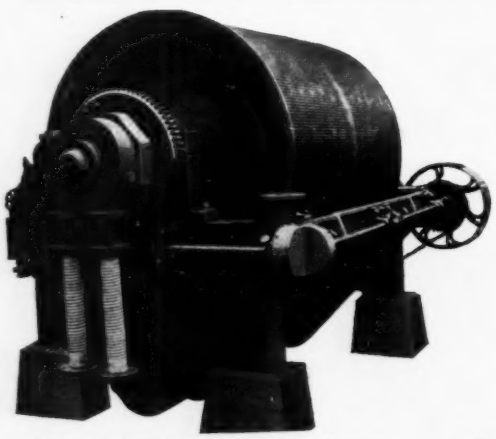

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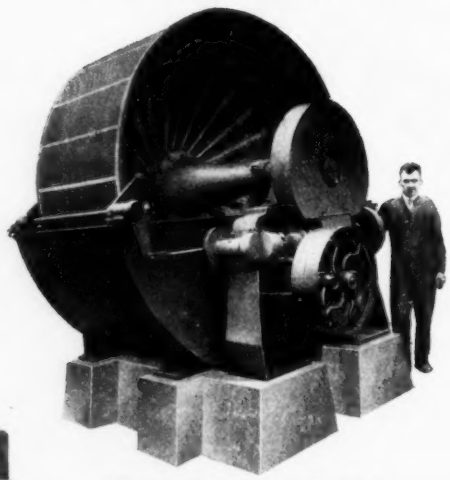

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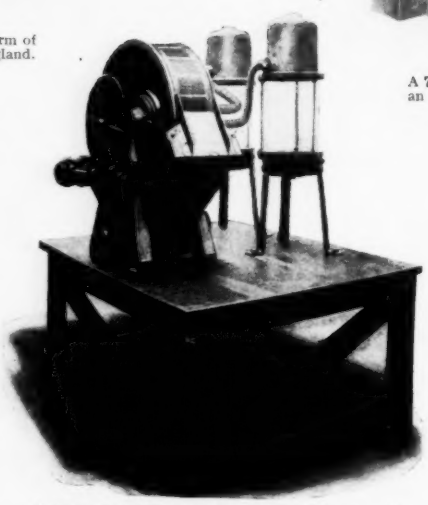

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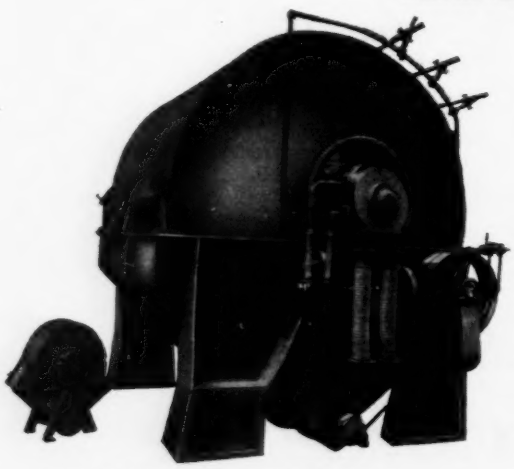

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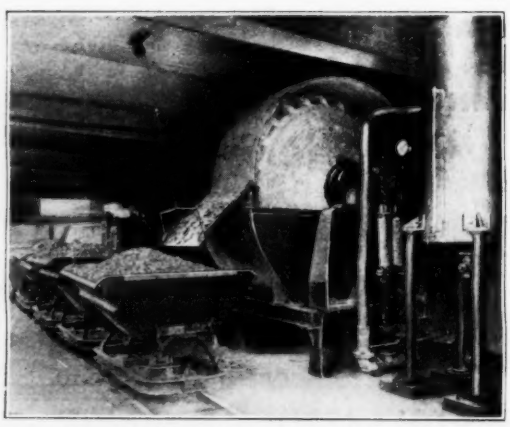

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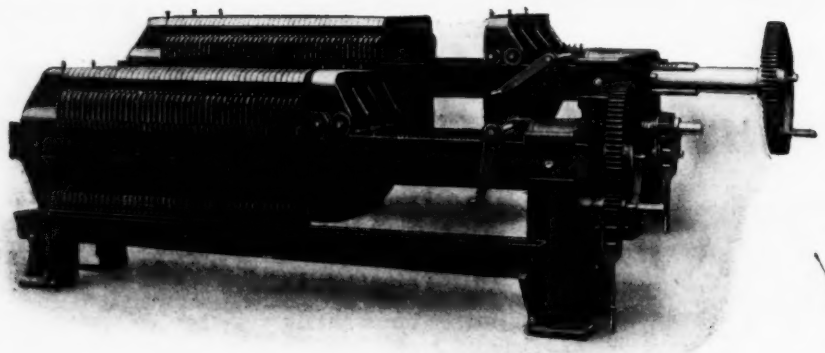

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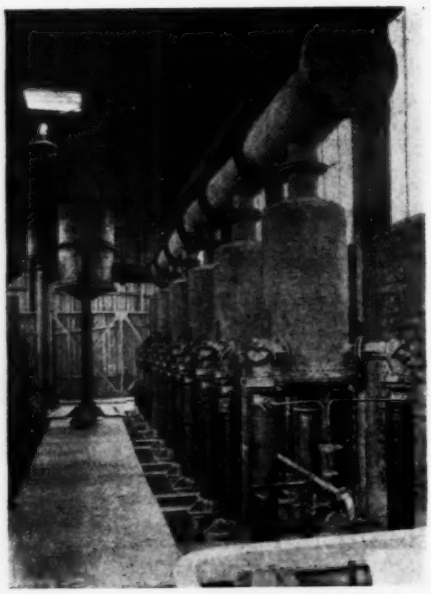

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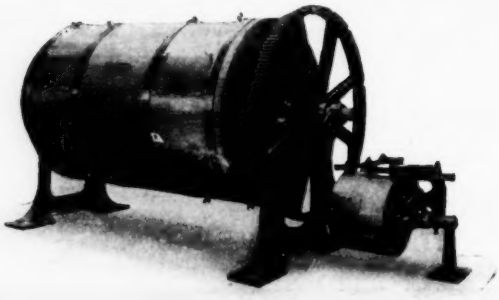

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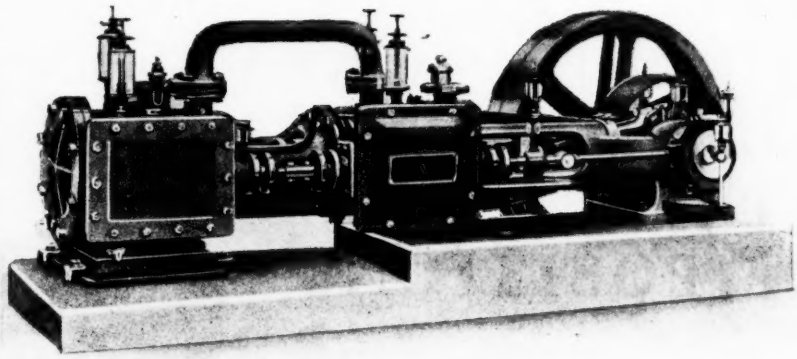

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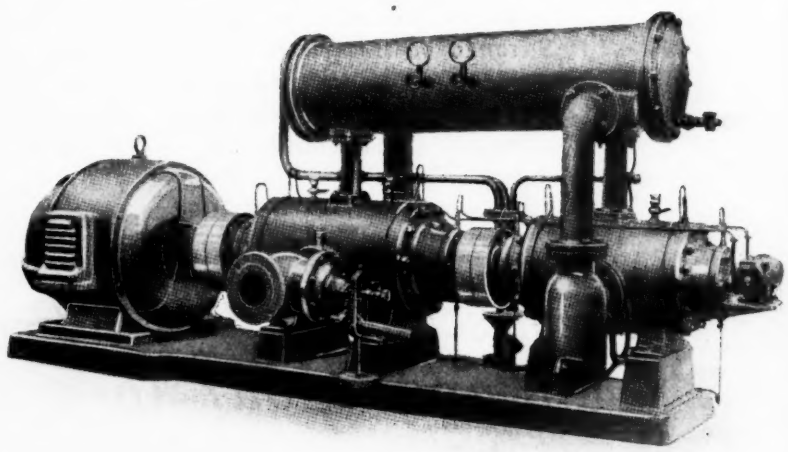

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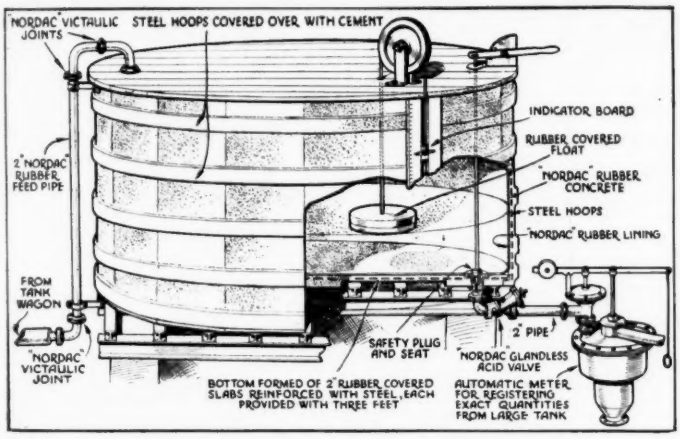
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RUBBER COVERED FLOAT
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"NORDAC" RUBBER CONCRETE
STEEL HOOPS
"NORDAC" RUBBER LINING
FROM TANK WAGON
2" PIPE
"NORDAC" VICTAULIC JOINT
SAFETY PLUG AND SEAT
"NORDAC" GLANDLESS ACID VALVE
BOTTOM FORMED OF 2" RUBBER COVERED SLABS REINFORCED WITH STEEL, EACH PROVIDED WITH THREE FEET
AUTOMATIC METER FOR REGISTERING EXACT QUANTITIES FROM LARGE TANK

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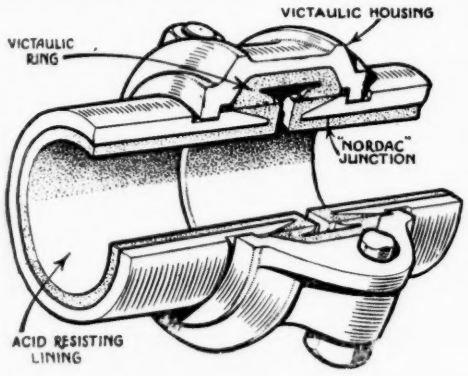
The Nordac patent junction enables existing plant to be lined with any quality of rubber and such plant already lined comprises the following :—old Lancashire boilers; existing dye becks; pickling tanks; old paper mill beaters; crystallising vats; bleaching becks for artificial silk; filters for dye stuffs and colours.

Rubber Lined Pipes



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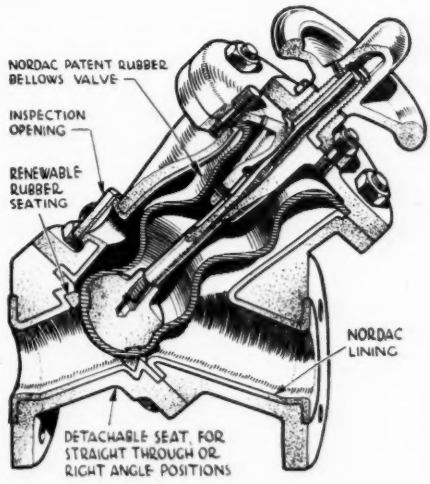
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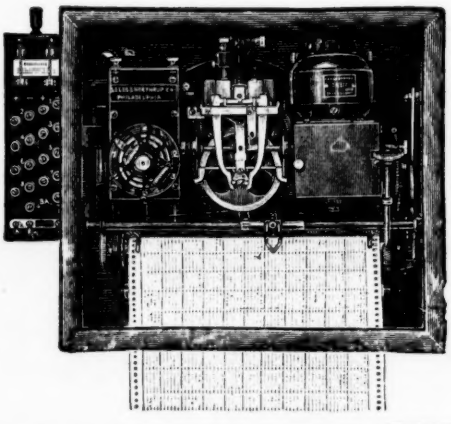

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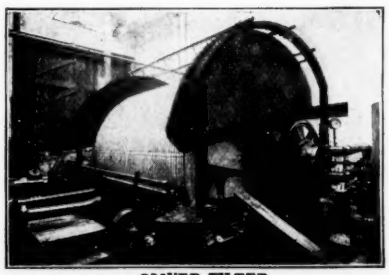

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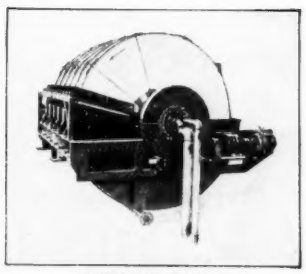

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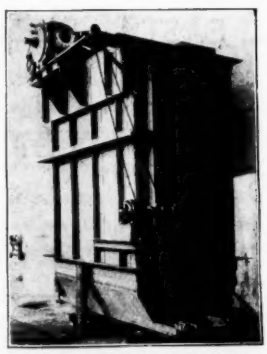

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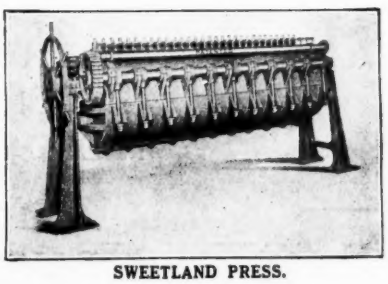

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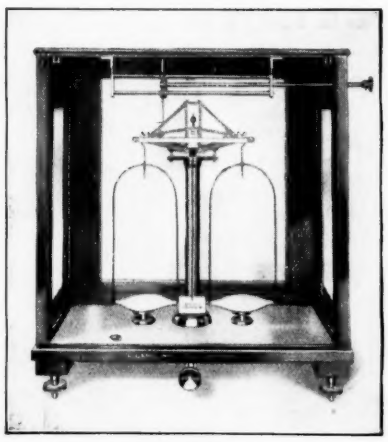

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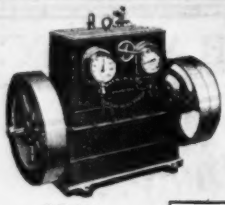

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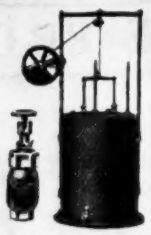

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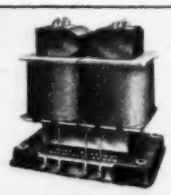

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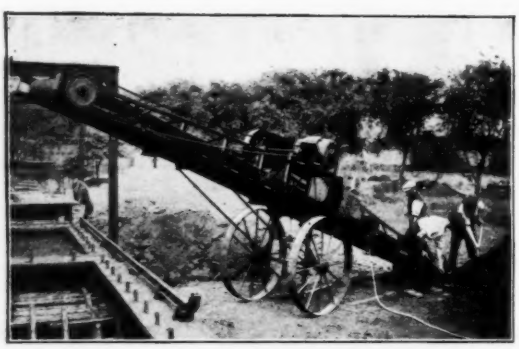

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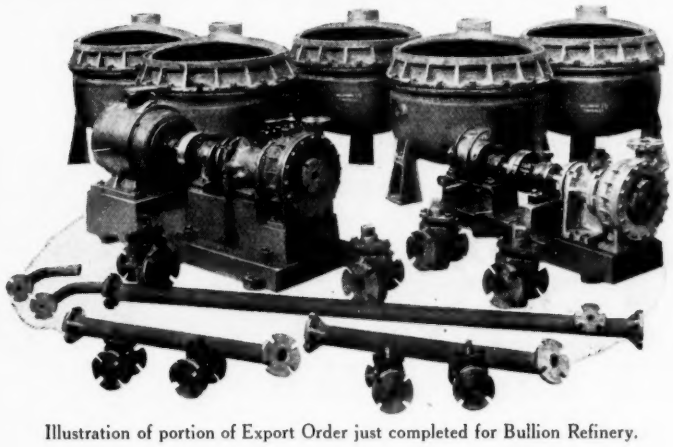

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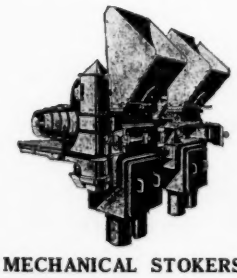

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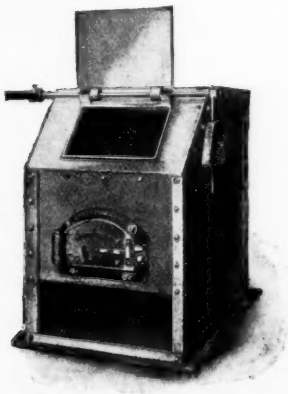

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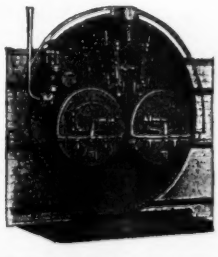

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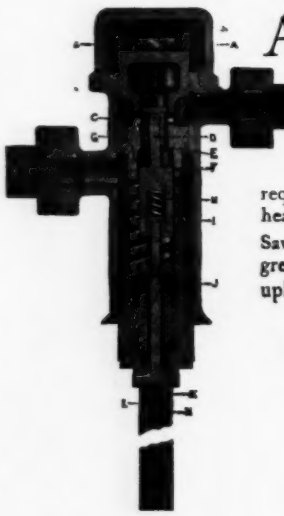

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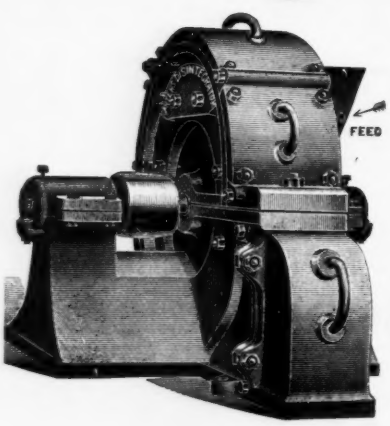

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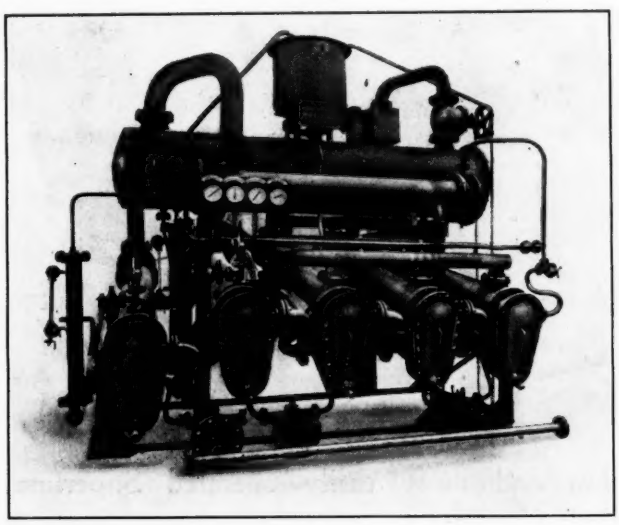

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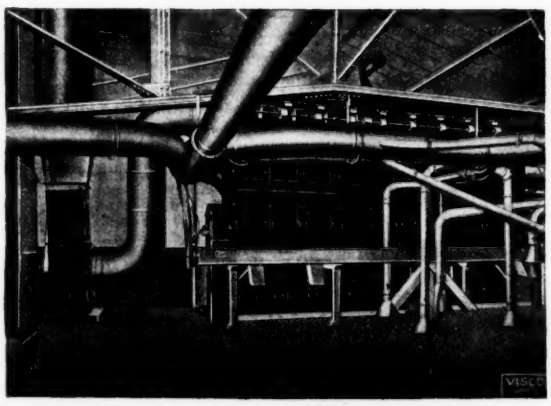

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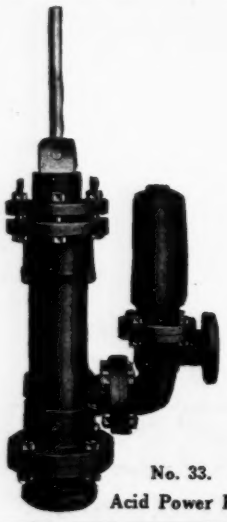

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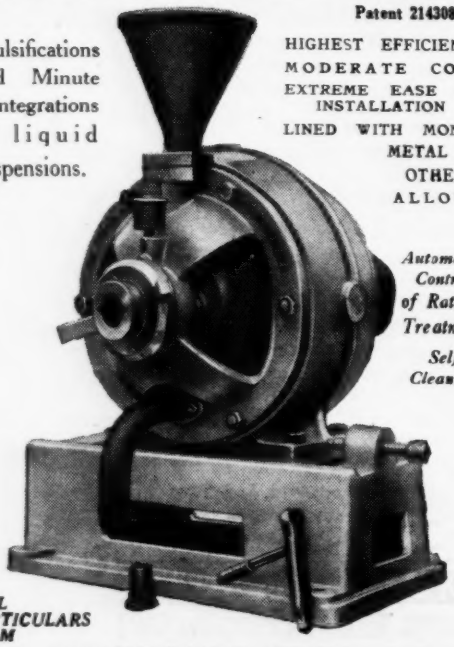

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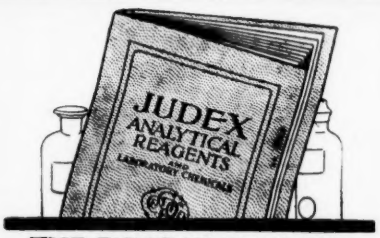

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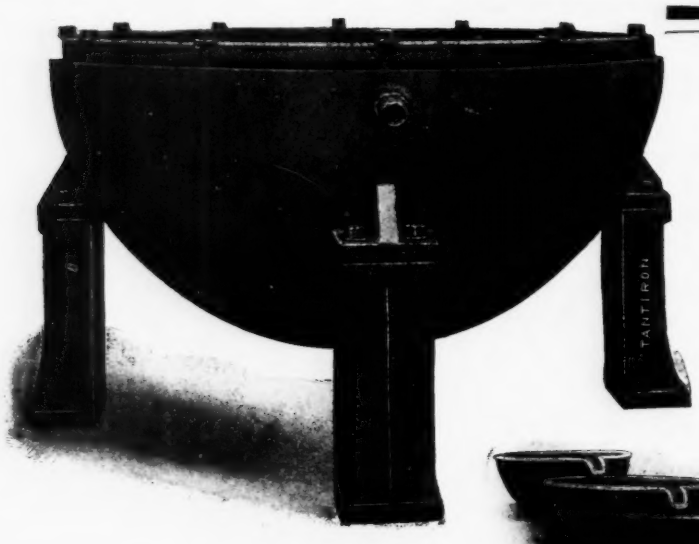

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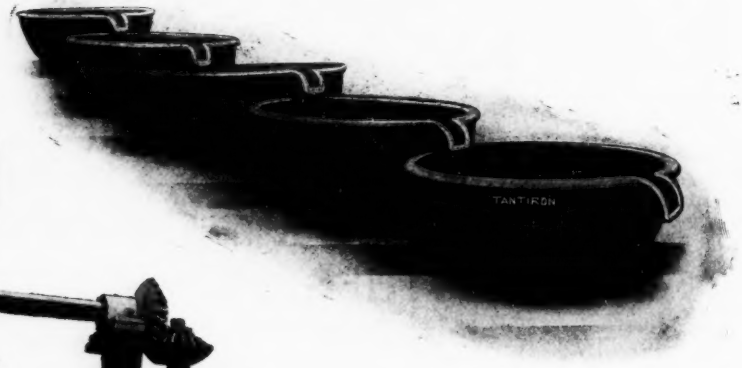

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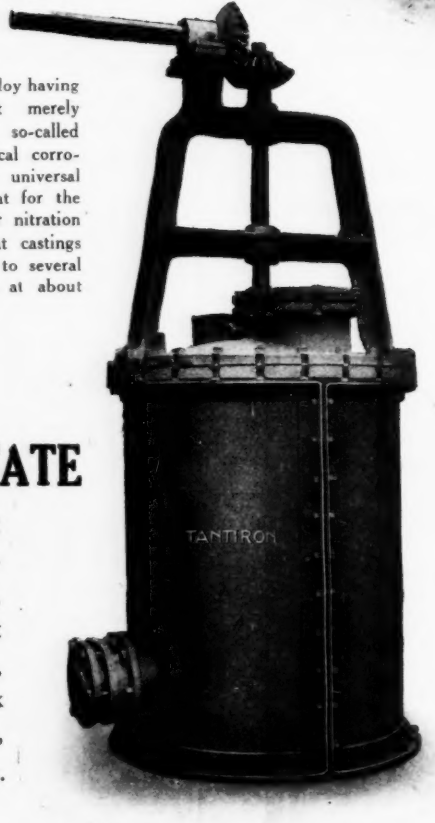

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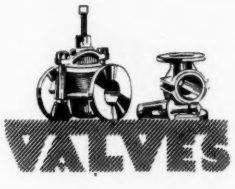

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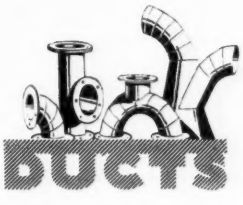

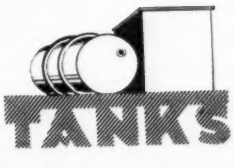

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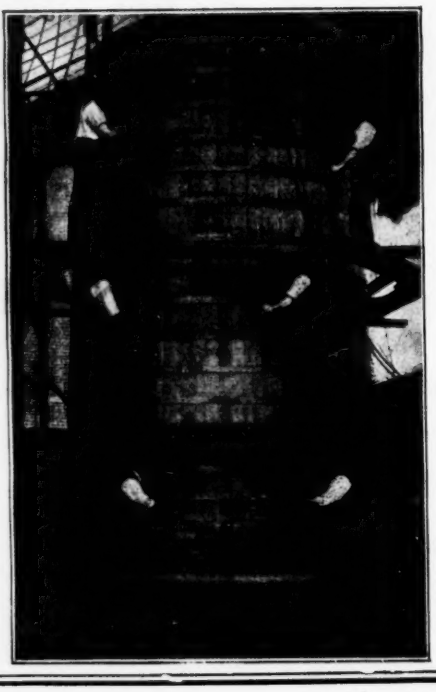

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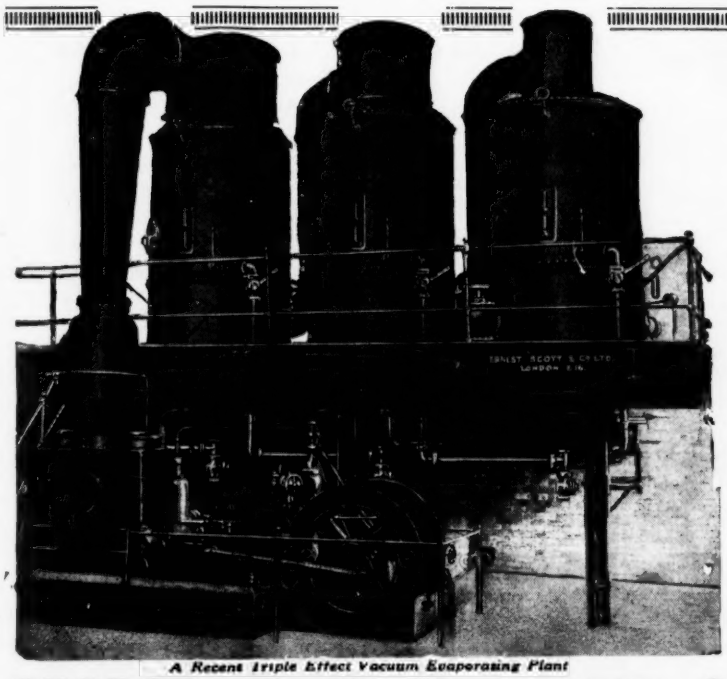

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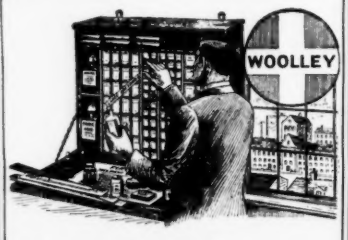

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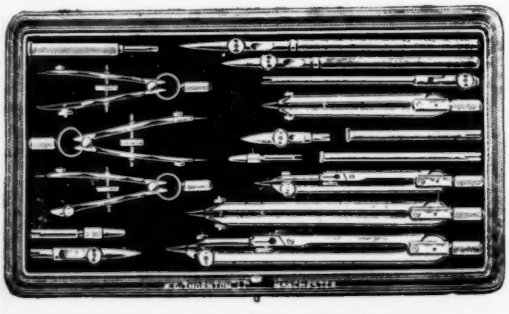

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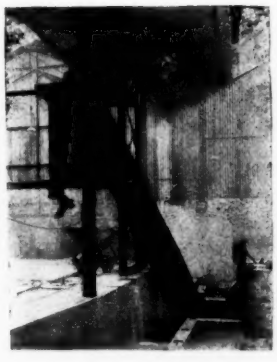

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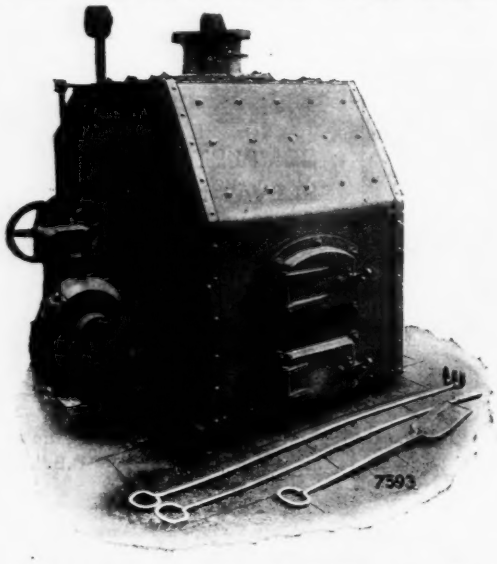

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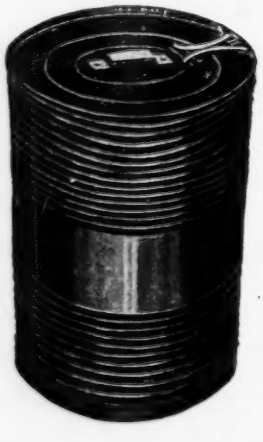

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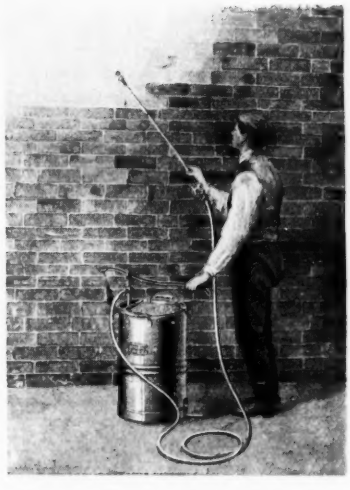

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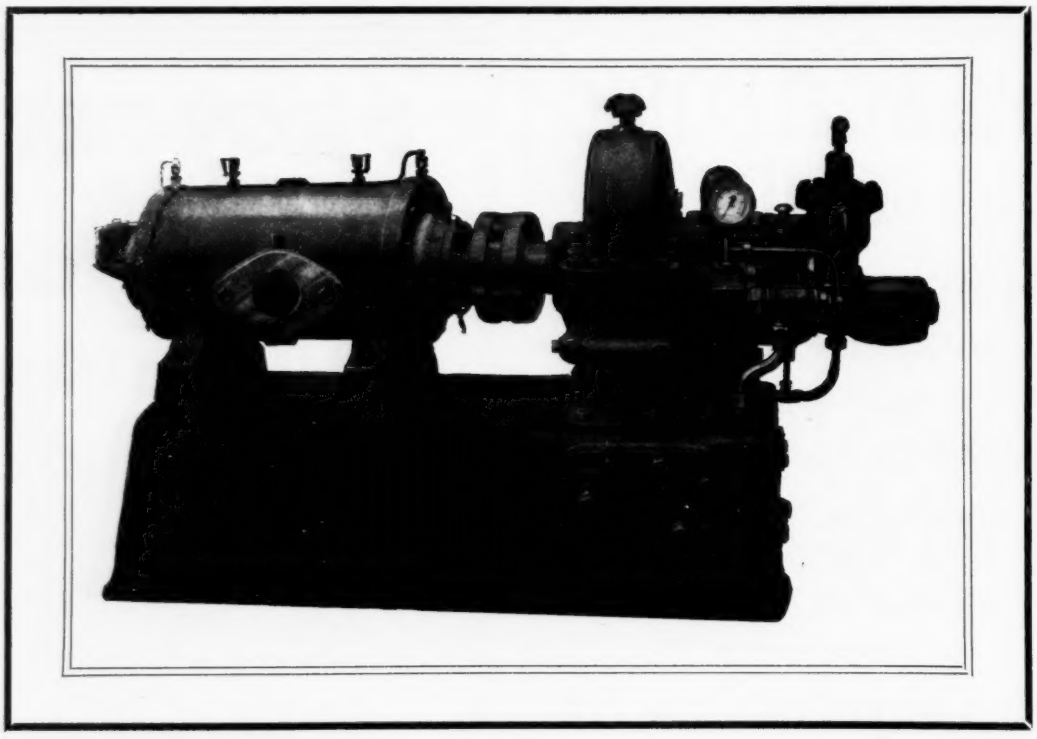

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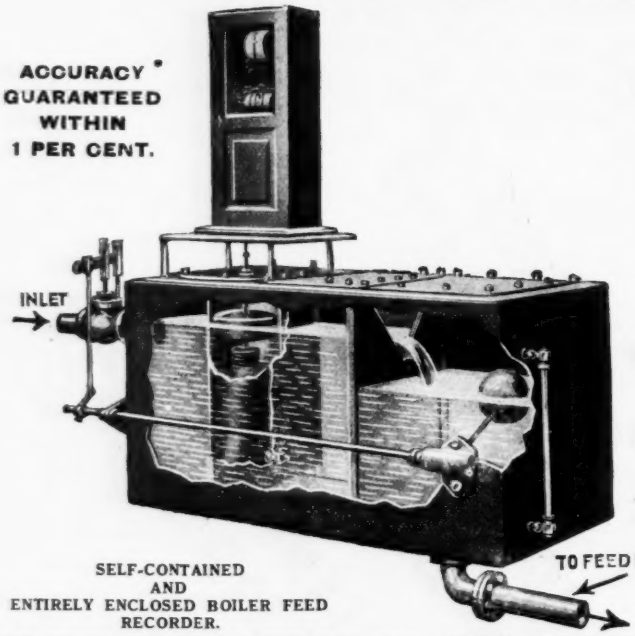

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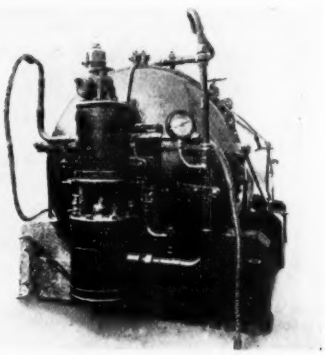

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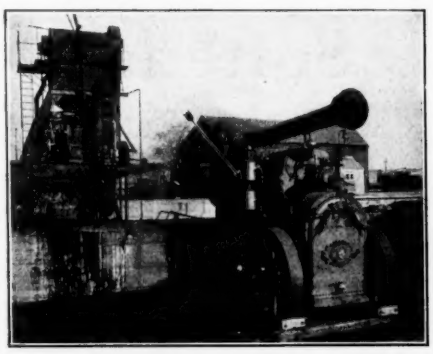

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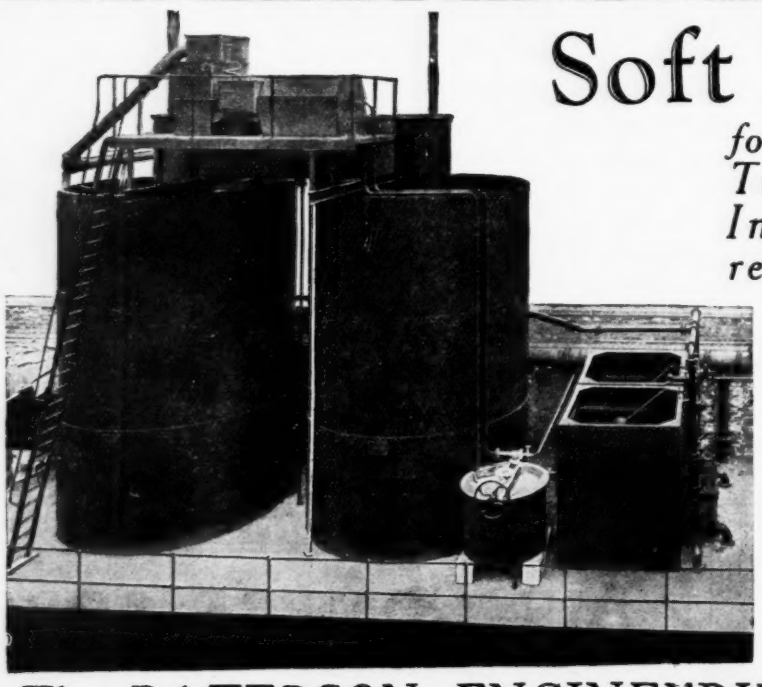

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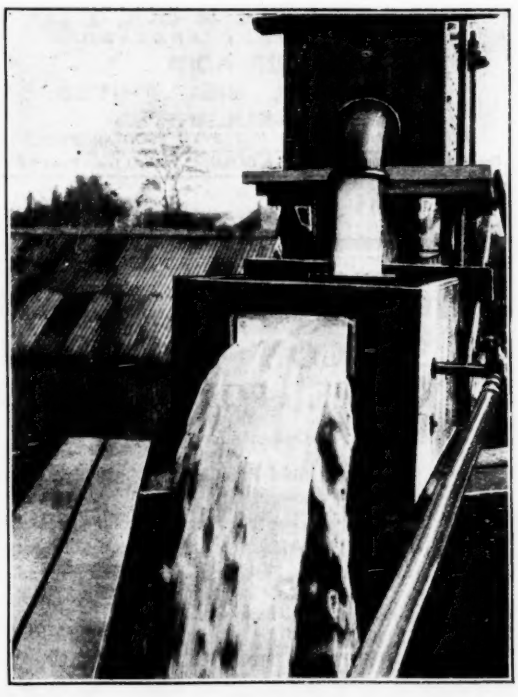

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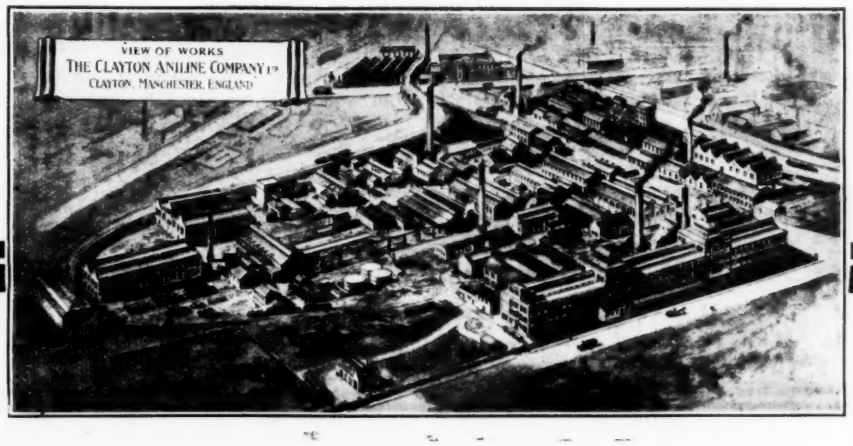

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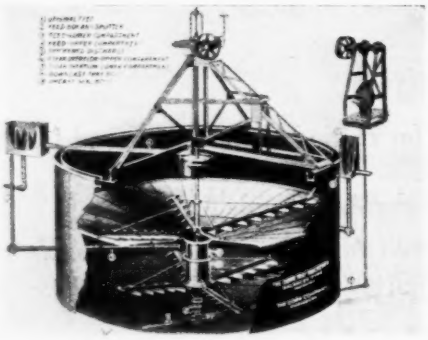

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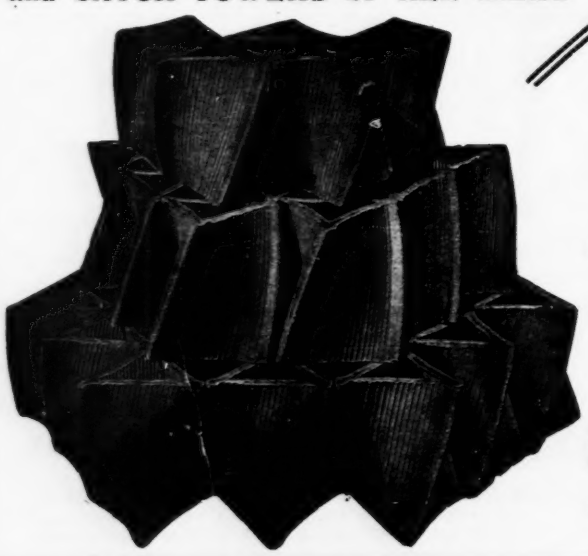

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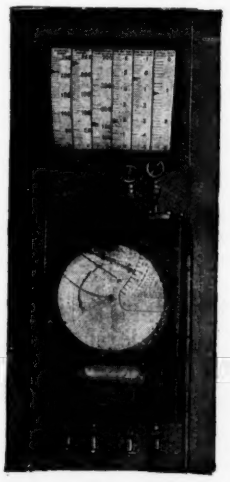

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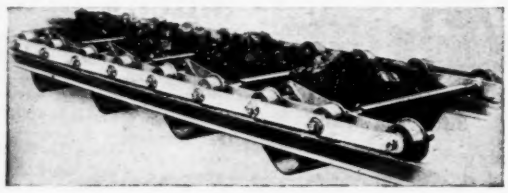

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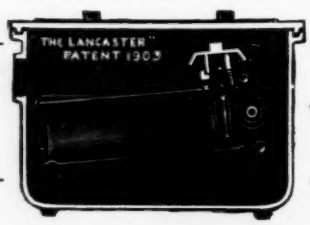

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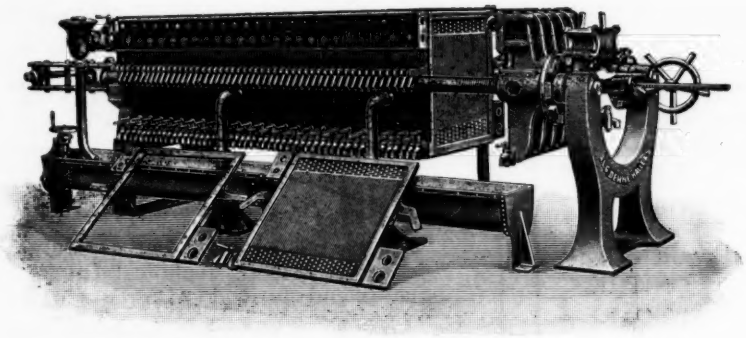

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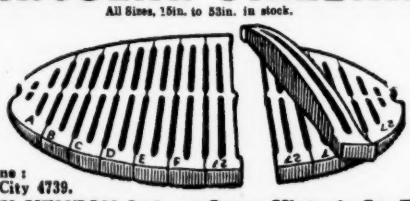

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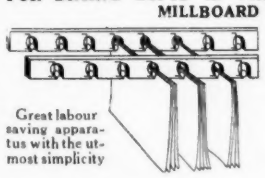

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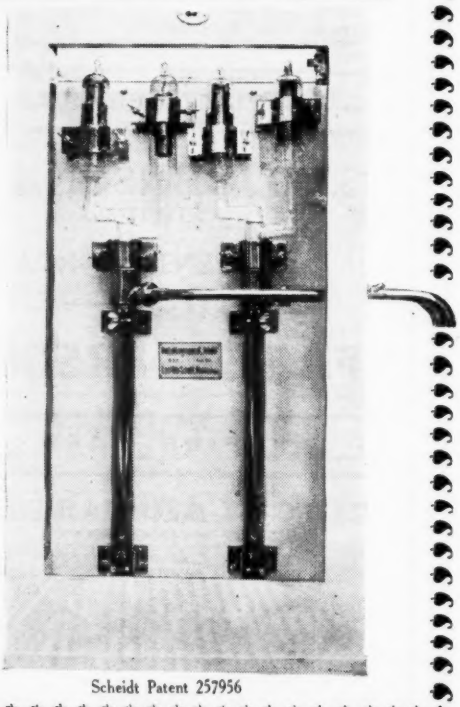

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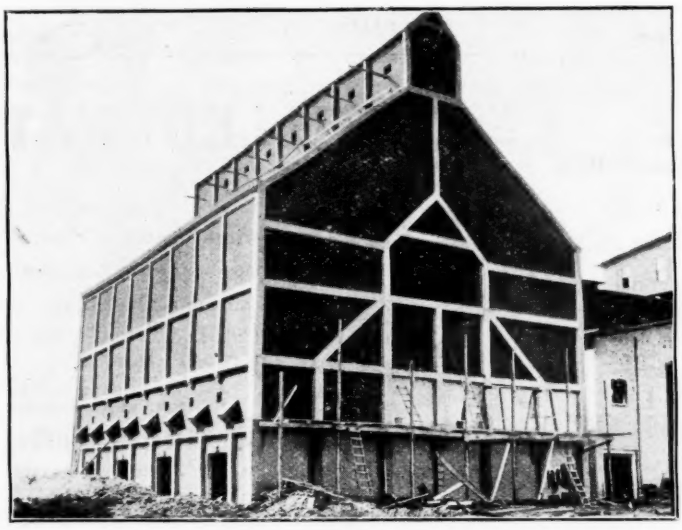

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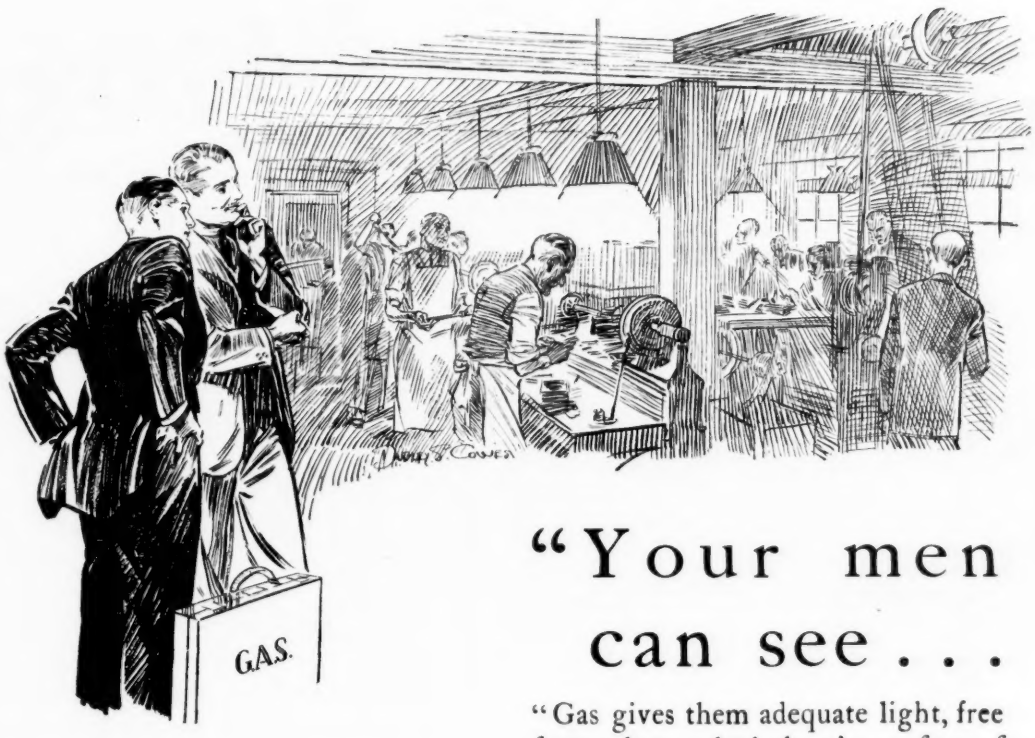

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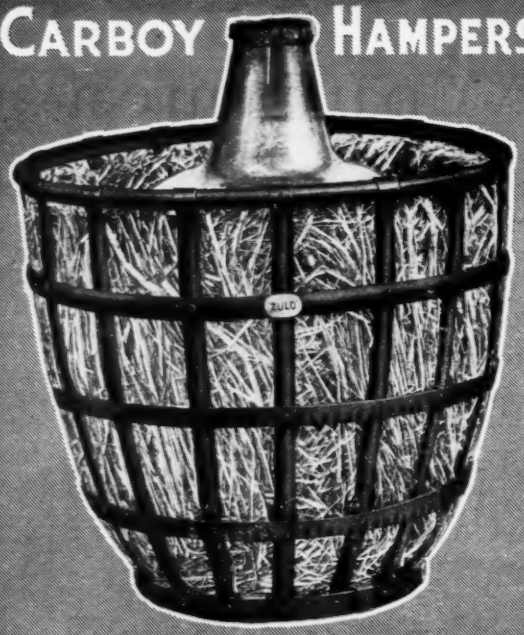

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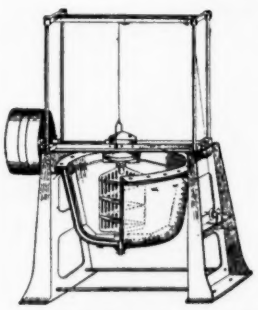

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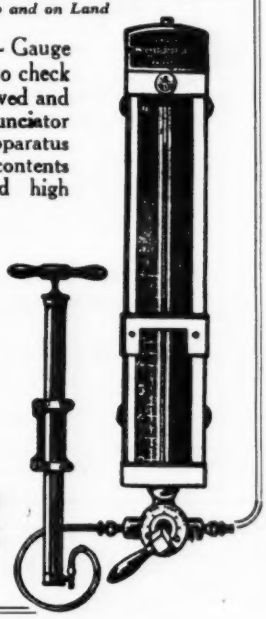

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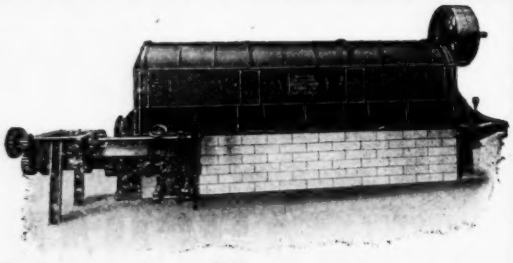

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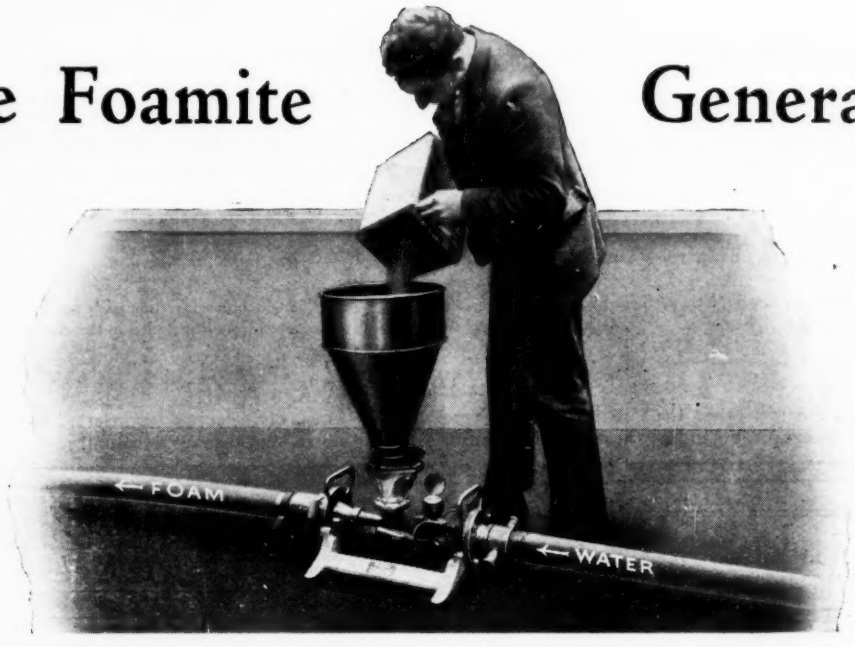

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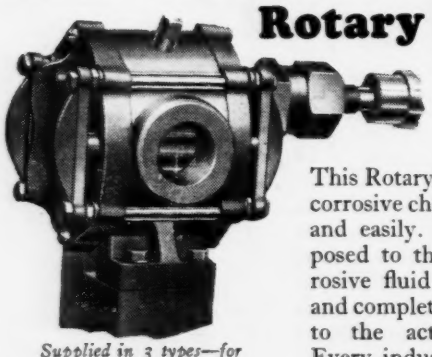

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